MODERN
Machine Shop
January, 1933

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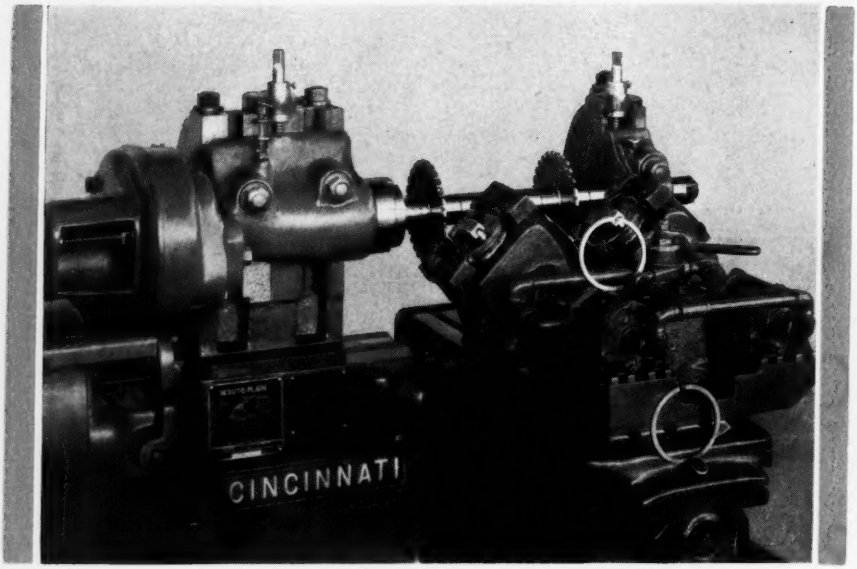

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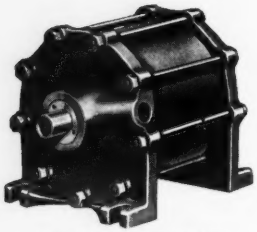

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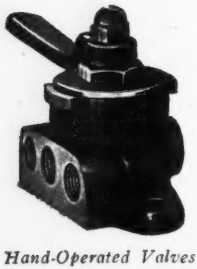

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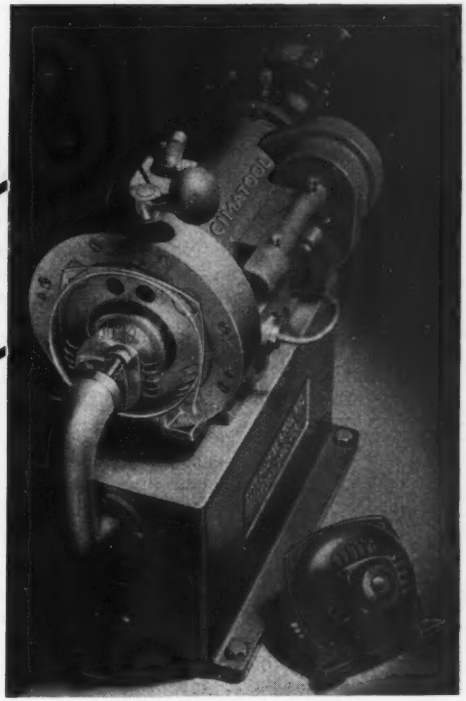

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MODERN Machine Shop

HOWARD CAMPBELL, Editor

Volume 5 JANUARY, 1933 Number 8

A Magazine for Machine Shop Executives

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MODERN Machine Shop

CINCINNATI, OHIO

JANUARY, 1933

VOL. 5, No. 8

Now You Can Spray Molten Metal » » »

The author describes a process by which any kind of surface can be coated with practically any kind of metal, to any thickness.

By PAUL HOWARD

SOME fifty years ago a German inventor patented a process by which fine particles of metal could be sprayed over any kind of base substance, forming a metal coating that would protect against corrosion. Due to certain difficulties which arose, however, the process was laid aside and received no serious consideration until the World War. When the shortage of copper in Germany reached the acute stage, the process was revived for use in spraying iron with zinc, to serve as a substitute for copper.

Sometime later a group of American engineers formed a company—

Fig. 1—Using a Metallizer to apply a coating of lead to the inside of a section of steel pipe for use in a paper mill.

the Metallizing Company of America, Inc., Los Angeles, Cal.—to develop the process to its utmost possibilities. Their efforts have been so successful that the process is now in constant use in a number of plants throughout the country. Metal units that are too large to be plated or coated in any other way are coated by the Metallizing process to a thickness of from

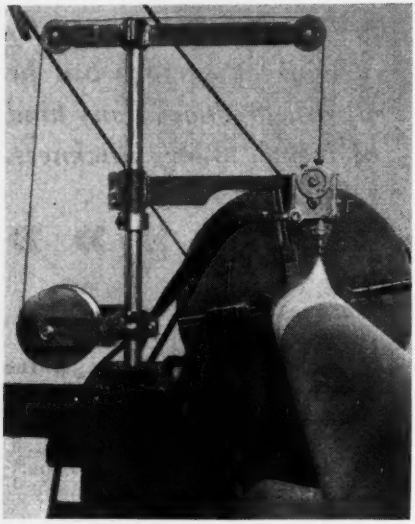

Fig. 2—Utilizing a lathe, with its automatic feed, for Metallizing a roll for a paper machine.

0.002 to 0.018 in., depending on the condition to be overcome. Coatings are applied as a protection against corrosion or erosion.

Tanks, boilers, and machinery used in the chemical industries, dairies and milk plants, oil industries, sugar mills, and other industries are Metallized with lead as a protection against the damaging effects of the acids. Metal units which are exposed to salt air are coated with metals that are impervious to corrosion. In the coal and oil-burning districts cast-iron bars are sprayed with aluminum to double their life. Heat corrosion is prevented or retarded by the application of a coating of aluminum.

Cracked or chipped glass-lined tanks which normally would be condemned are now salvaged by the application of tin inlays. Blow holes in castings are filled with metal by the Metallizing process, and the castings are saved from the scrap pile. Undersize shafts and other parts are built up to the required sizes by Metallizing. Stone, wood, plaster, concrete, paper, cloth, glass, or metal surfaces can be Metallized with practically any kind of metal, and to any thickness.

Briefly, the process consists of feeding wire into a gas flame that is hot enough to melt it instantly, and atomizing the molten metal, the entire process being automatic. To do this, the wire is fed through the Metallizer, which is a small piece of apparatus that can be held in one hand and to which are attached both the hose lines from the acetylene (or hydrogen) and oxygen tanks and the air-hose. The oxy-acetylene flame melts the metal and the compressed air performs the double function of operating the wire feed turbine and atomizing the metal after it has been melted.

Any metal that is procurable in wire form can be sprayed, the speed of application depending on the melting point of the metal. The average single coat of metal is about 0.002 in. thick, but any number of coats can be applied where a thick coating is desirable. The coated surface can be polished or ground without danger of the coating peeling or flaking.

To prepare for operation, the operator inserts the end of the wire through the feeding mechanism and lights the gas flame. With the work ready and the flame properly adjusted, he opens the air valve and thus starts the wire feeding into the flame. Im-

Fig. 3—Applying a lead coating to the inside surface of a large acid sand filter tank used in the production of oil.

mediately a spray of minute molten particles is projected from the nozzle at a speed of approximately 30,000 feet per minute. However, in spite of the high speed and the fact that the particles have just been through a flame of perhaps 5,200 deg. F., they cool almost instantly upon striking the surface at which they are aimed and adhere firmly.

The only special preparation required for Metallizing is that the surface to be Metallized must first be sand blasted. The sand blast is necessary to remove all oil, grease, moisture, or other substance which might prevent proper adhesion, and to roughen the base surface so that maximum adhesion may be outlined. The terrific impact of the atomized metal with the base surface drives the coating metal into the pores in the base to which it is being applied, where it cools almost instantly and becomes practically an integral part of the base substance.

In operation, the Metallizer is held directly over the work so that the spray hits the work with the maximum force obtainable. Usually the Metallizer is held in the hand, but it is possible to hold it mechanically and feed it automatically. In one case where a metal coating was to be applied to a large cylinder, the cylinder was swung between centers in a large lathe and revolved at a slow rate of speed while the Metallizer, clamped in position over the work, was fed longitudinally by the use of the thread-feed.

The speed of application depends principally upon the melting point of

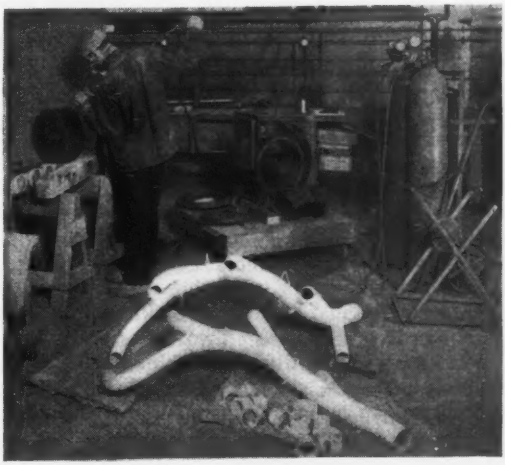

Fig. 4—Metallizing a blower with lead as a protection against the corrosive action of acid fumes and heat. The airplane motor exhaust manifolds in the foreground have been coated with aluminum to protect them from heat corrosion.

the metal used for coating. In a laboratory test, flat surfaces were coated with lead at a rate of more than 180 square feet per hour. Under average working conditions, with an average workman, using hydrogen gas, the following rates can easily be attained:

Zinc .....120 sq. ft. per hr. per coat
Tin .....120 sq. ft. per hr. per coat
Lead .....120 sq. ft. per hr. per coat
Brass .....80 sq. ft. per hr. per coat
Nickel silver..50 sq. ft. per hr. per coat
Aluminum ...60 sq. ft. per hr. per coat

These speeds can be increased by using acetylene gas instead of hydrogen.

The above figures are for a "smooth" coating, which leaves a surface that is a bit smoother than the finest sand paper. Rough coatings can be applied faster, but lack the required density. The thickness of the coat and the surface covered depends, of course, on the judgment of the operator and the adjustment of the Metallizer. Hard metals, such as bronze, nickel, silver, and copper, usually deposit to a thickness of 0.0015 in. per coat, while the softer metals, like tin and lead, coat to a thickness of from 0.002 to 0.0025 in. It is possible to apply a heavy coating and then machine or grind the surface to the required dimension or thickness.

Costs per square foot vary according to labor costs and the metals being used, and reduce as the skill of the operator increases. Two coats of metal are generally advisable and sometimes more, depending upon the conditions to be overcome.

Probably the greatest value of the Metallizing process lies in its use as a preventative of corrosion. Any object that is exposed to weather, rust, heat, chemicals, or salt air can be Metallized with a coating that will render it immune to corrosion. On galvanized work, where the galvanizing has been burned or chipped off, the sheared edges can be Metallized with zinc.

The illustration Fig. 1 shows a Metallizing outfit, including a portable air compressor and the necessary acetylene and oxygen tanks, in use in the plant of the Enterprise Machine Company, Middletown, Ohio. Since the Metallizer was installed in this plant, which is a large jobbing and contract shop, work to be Metallized has been drawn from a wide variety of manufacturing plants in the adjacent territory, including paper mills, dairy equipment manufacturers, soap factories, machine tool plants, airplane plants, chemical plants and chemical machinery manufacturers.

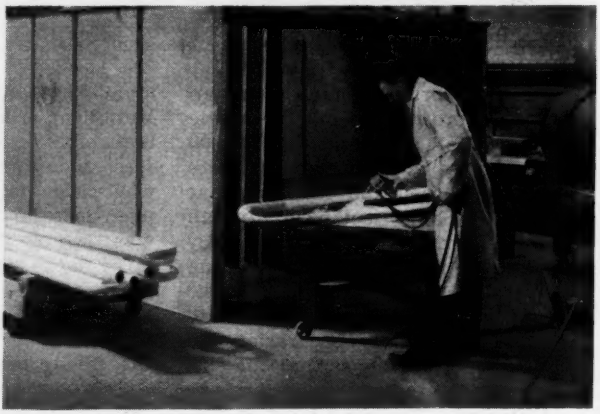

Fig. 5—Pipe coils are coated with aluminum to prevent the corrosive action of heat and chemicals.

The operator is shown here applying a coat of lead to the inside of a section of steel pipe for the stock line in a paper mill. The pipe is of the "Armco Spiral-Welded" var-

iety, 20 in. in diameter, and the lead was applied to a thickness of 0.007 in. The cost of this steel pipe, lead-lined, was about 25 per cent less than that of the heavy cast iron pipe which was previously used for this purpose.

One of the most interesting jobs performed in this shop was that of Metallizing a paper machine roll that had become so badly pitted as to be useless. The roll was placed in a large lathe and the rough surface was turned off, then it was sand blasted to provide the necessary bond for Metallizing. The roll was then placed back in the lathe and an attachment was bolted to the carriage of the machine so that the Metallizer could be held in the proper position, as shown in Fig. 2.

Using the lead screw for feeding, with a slow speed, a coating of zinc from 0.003 to 0.004 in. thick was applied as a base. Then two coats of copper were applied, each coat being 0.005 in. thick, and the roll was burnished with smooth steel rollers in a holder similar to a knurling tool holder. The rolling process had the effect of both flattening and compressing the copper coat. After rolling, the roll was polished with a No. 150 rag wheel. In this manner the roll was reclaimed at a considerable saving over the cost of a new roll.

In Fig. 3 two operators are shown in process of applying a lead coating to the inside surface of a large acid sand filter tank for one of the major oil companies. The filter is a part of the oil-producing equipment and is subject to erosion by the combination of oil and sand. Ample protection is provided by coating with from 0.006 to 0.008 in. of lead.

The operator shown in Fig. 4 is Metallizing a blower with lead as a protection against the action of acid fumes that are generated in the storage battery room of a yacht in which the blower is used. In the foreground in this illustration can be seen, also, several exhaust manifolds for airplane motors, which have been coated with two coats of aluminum each to prevent heat corrosion. This method of treating parts that are to be subjected to high temperatures, such as burners, grate bars, boilers, smoke stacks, and so on, has been found to greatly increase the life of the part thus treated.

Fig. 6—Polishing a milk cooler after Metallizing.

In Fig. 5 an operator is shown applying a coating of pure aluminum, 0.015 in. thick, to pipe coils that are to be installed in perfume-manufacturing tanks in a soap factory. The aluminum protects the coils against the action of heat and chemicals.

A piece of milk plant equipment is shown in Fig. 6, in process of being polished after Metallizing. Such equipment is made of copper which is afterward coated with tin to a thickness of 0.006 in. to prevent the milk from absorbing the copper flavor.

The examples shown here will indicate the possibilities of the process and serve to show, to some extent, the manner in which Metallizing is being used both as a manufacturing operation and in the reclamation of equipment that otherwise would require replacement.

THERE IS PROBABLY AN INV

His name is obsolescen
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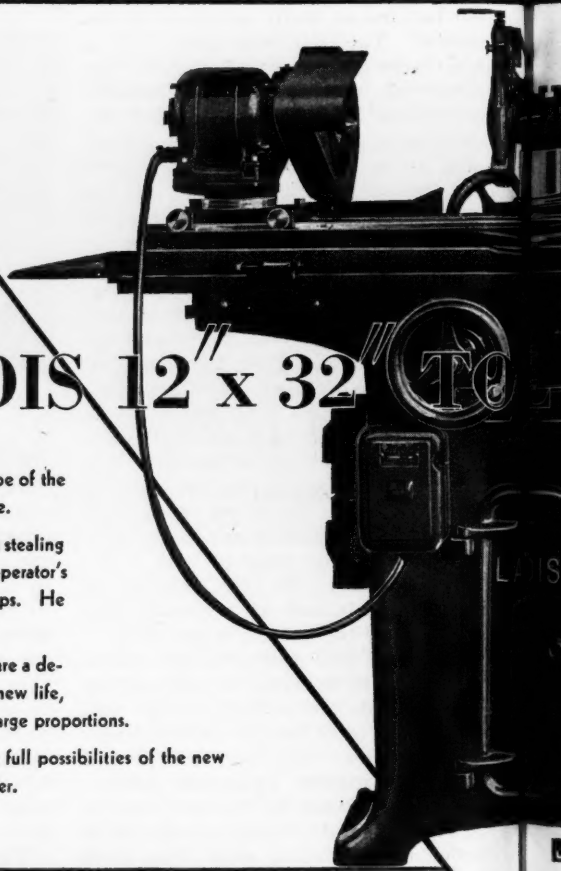

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Removing Vibration by Dynamic Balance

A concise, but lucid, explanation of the cause and effect of unbalance, with instructions for its removal

By H. W. MOORE
President, Globe Tool & Engineering Co., Dayton, Ohio

IT IS indicative of the machine age in which we are living that the average person is "vibration-conscious." Vibration in our automobiles, electric refrigerators, vacuum cleaners, and office appliances such as dictaphones, electric fans, and so on, has forced itself to the attention of the users of these mechanical units to such an extent that, in many cases, it constitutes effective sales resistance. This form of sales resistance is recognized by manufacturers, engineers, and designers, to whom the damaging effects of vibration are well known.

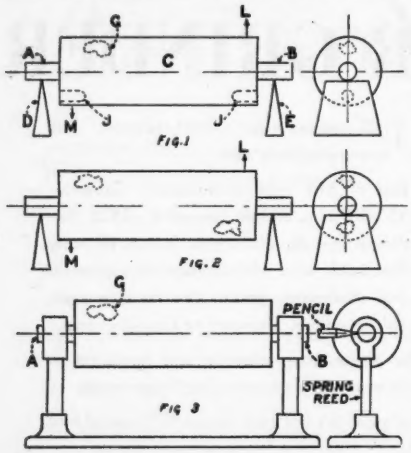

Fig. 1—Drawing illustrating static method of balancing. Fig. 2—Note the invisible blowholes. This shaft is balanced statically, but badly out of balance dynamically. Fig. 3—This drawing illustrates the principle of the modern-type dynamic balancing machine.

Vibration is caused by lack of balance in the rotating parts of machinery. It has always been a source of trouble to engineers and designers, due not only to the fact that the excessive wear on the bearings caused by vibration affects the accuracy and life of the machine, but also to the fact that the exact point of "unbalance" has been difficult to locate and consequently difficult to correct. However, such correction is more important today than ever before, as all mechanical equipment is running at higher speeds than formerly. And as the force of unbalance increases in proportion to the square of the speed of the rotating unit, the damaging effect of unbalance increases accordingly.

In the past, vibration has been eliminated to a certain extent through correction of the unbalance by static or "standing" balance. The part to be balanced is placed on knife edges which have previously been leveled, and the low spot, which has been determined by force of gravity to be the heaviest spot, is marked and afterward lightened by the removal of a certain amount of material. However, it has been observed that no matter how carefully the operation

has been performed, when the part is assembled in the machine and operated at high speeds, the unbalance still exists and is sometimes greater than before the part was balanced.

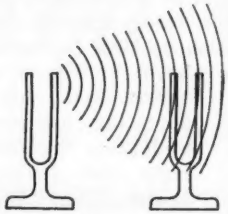

Fig. 4

Fig. 4—Sound waves produced by striking a tuning fork will produce vibrations in another tuning fork.

Thus it is clearly evident that it is impossible to determine, by static balance, the proper locations for correction weights in a lateral plane.

This point is best illustrated by the drawing Fig. 1, in which a cast cylinder **C** is shown mounted on the shaft **A - B** and the assembly placed on the knife edges **D - E.** It is assumed that the cylinder has been turned true, but that underneath the surface at the point **G** is a blowhole which is invisible. When placed on the balancing ways, the assembled shaft will roll and come to rest with the heavy spot down, which shows that the part is out of balance statically. To correct this condition, the mechanic will drill holes of equal depth into the sides of the cylinder at the points **J - J** until enough stock has been removed so that the cylinder will remain at rest in any position in which it is placed on the ways.

When the cylinder is rotated at low speeds, the vibration may not be serious, but as the speed is increased, the effect of the improper placing of the correction drilling will be apparent. The centrifugal force of the heavier side **L** will produce vibration in the bearing **B,** and the bearing **A** will vibrate due to the centrifugal force of the heavy point **M,** all of which is caused by inability to determine the amount of weight to correct for on either side of the cylinder.

In Fig. 2 is shown a similar cylinder with two blowholes at points 180 degrees from each other and on opposite sides of the cylinder. If these blowholes displaced approximately equal weights of metal, the cylinder when placed on the balancing ways would appear to be in good static balance. Upon rotating the cylinder, however, a vibration corresponding in intensity to the speed would be set up by the centrifugal force of the heavy sides **L** and **M.** Such unbalanced forces may occur in any amounts and at any angles from each other; thus correcting for running balance by static methods becomes an impossibility.

The only solution consists in balancing the part dynamically, which means that the force of unbalance on either side must be measured and the angle at which the correction should

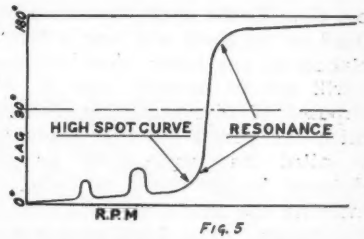

Fig. 5

Fig. 5—Chart illustrating the relation of "lag" to speed on flexibly-mounted rotating parts.

be made must be located. This can be done by the use of a properly-designed dynamic balancing machine. After the part has been properly balanced dynamically, it can be rotated at any speed within the safety factor

of the material without apparent vibration.

If the cylinder is mounted on bearings that are flexibly mounted as shown in Fig. 3, and is rotated by external means, the bearings **A** and **B** will vibrate, although **A** will vibrate more than **B**, as the blowhole is nearer to the bearing **A**. Now, if a pencil is held close to the shaft, the mark produced on the shaft will bear a definite relation to the heavy spot, although it will not be directly over it. For purposes of discussion the point at which the pencil mark is made will be called the "high spot," as it is produced by the force of unbalance throwing the shaft out of its center of rotation. The high spot always lags behind the heavy spot in the cylinder from a few degrees to nearly 180 degrees, depending upon two conditions—the resiliency of the bearing mountings, and the speed at which the part is rotated.

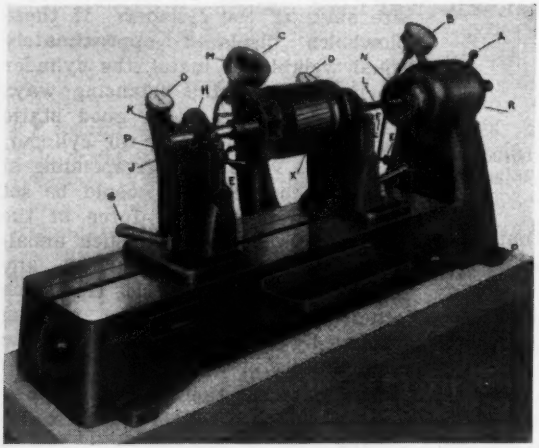

Fig. 6—Dynamic balancing machine in which a Neon light is used to locate the point of unbalance.

On rigid mountings, the lag stays below seven degrees; on flexible mountings, the lag will be below seven degrees at the start but will quickly approach 180 degrees as soon as the critical speed of the mounting has been passed. This critical speed is the speed at which the frequency of vibration of the rotating part is in harmony or resonance with the period of vibration of the mounting. The mounting shown in Fig. 3 is a flat spring reed. All bearing mountings are resilient to a degree, regardless how rigid the design; weak bearing pedestals have a low frequency, while the frequency of heavier, more rigid pedestals is higher.

Occasionally the vibration of a rotating part in a machine vibrates the whole machine, which in itself has a period of vibration. A good example of this condition is the automobile; at low speeds the motor usually runs smoothly, but as the speed is increased, one or more periods of vibration are noticed. These periods of vibration in the motor may synchronize with the vibration of the entire frame of the car, or with various metal parts, as the points of resonance of these parts are reached. Rubber mountings are now used to reduce the effect of vibration in automobile motors. They do not eliminate it, but they lower the frequency to a point that does not come within the normal operating ranges of the motor. The damaging effect of the vibration upon the bearings of the motor is still present.

"Critical speed" can best be illustrated by placing two tuning forks of the same pitch or resonance near each other. When one fork is struck, a vibration will be produced in the

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other although there is no mechanical connection between the two. This vibration of the unstruck fork is caused by the repeated, but slight, effect of the sound waves set up by the struck fork, as illustrated in Fig. 4. The two forks having the same

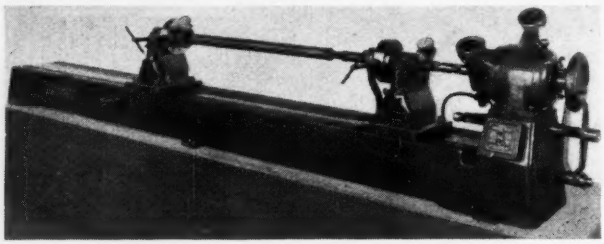

Fig. 7—Special balancing machine for balancing automobile universal shaft joints.

frequency, the small repeated impulse of the sound wave gradually increases the vibration of the unstruck fork until it has almost the same amplitude of vibration as the fork that was struck. If the two forks are brought to rest and a violin is played near them, a tone of the violin will be found that will start both forks vibrating violently. This tone is the same pitch as the forks; thus the forks are said to be in resonance, and the frequency of the tone is said to be the resonant or critical frequency of the forks and violin.

In our automobiles, electric refrigerators, or other machines that vibrate objectionably, this critical frequency is synonymous with the speed at which the vibration of the motor synchronizes with the inherent frequency of other parts of the machine. Most of the vibration can be eliminated by proper dynamic balance, but as it is not practical to balance to a state of absolute perfection, due to the cost, thought should be given to improving the design by strengthening weak parts or by bracing so as to either eliminate the resonant vibrations of these parts entirely or raise them to a pitch that will not be in resonance with the operating speeds.

The graphic chart, Fig. 5, illustrates the relation of lag to speed on flexibly-mounted rotating parts. It will be noted that, at the low speed, the lag is practically zero. As the speed is increased, the lag increases slowly to a narrow speed zone of 90 degrees, which is the "resonance" speed or critical point. If this zone is passed, the lag approaches 180 degrees immediately. It will be noticed, however, that smaller critical speeds are indicated on the lag curve. The frequencies at these speeds are har-

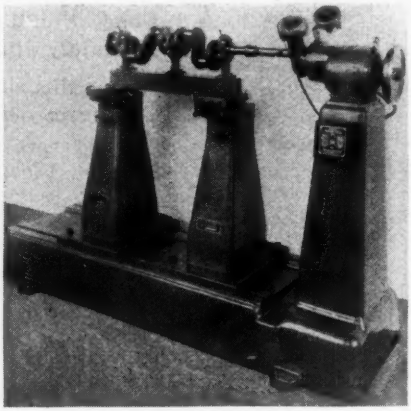

Fig. 8—Vibration is eliminated by correcting dynamic unbalance in crankshafts.

monics of the major critical speed, the relation being the same as the relation of the octaves on a piano.

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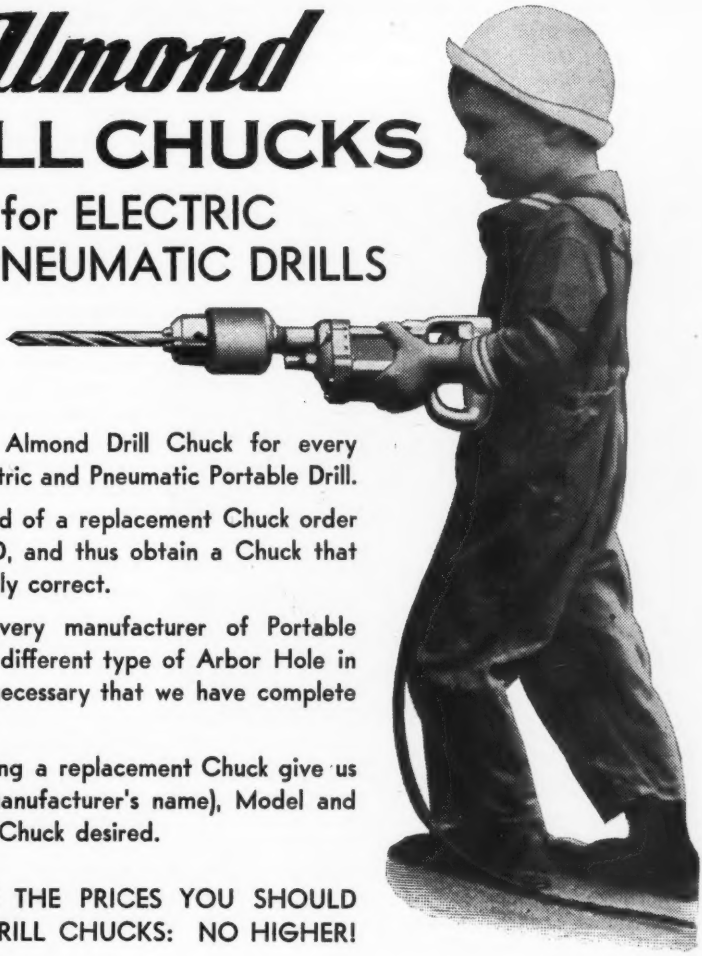

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When in need of a replacement Chuck order an ALMOND, and thus obtain a Chuck that is mechanically correct.

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3/16" Capacity	$3.00	1/2" Capacity	$4.50
1/4" Capacity	3.00	5/8" Capacity	4.50
5/16" Capacity	3.50	3/4" Capacity	6.00
3/8" Capacity	3.50	1" Capacity	7.00

J. R. Almond Mfg. Co.,
Ashburnham, Mass.

These harmonics are seldom serious, as they are so slight in force, but in rare cases they become a factor and must be adjusted for.

It will be noticed that the high spot indicated by the pencil mark on the shaft is erratic in its behaviour, which, to those not acquainted with dynamic balance and the behaviour of the "high spot," would make the determining of the heavy spot difficult. Previous discussion has shown that very small amounts of vibration, such as sound waves which have an infinitesimal mechanical force, can produce mechanical vibration that will actually wreck improperly-designed structures. Soldiers marching across an old-style suspension bridge are required to break step and thus avoid setting up a vibration which might wreck the bridge. Large steel beams can be made to vibrate violently by playing a violin in their immediate vicinity.

Fig. 9—Section of winding room in plant of Master Electric Company. All armatures and rotors are dynamically balanced, the balancing machines being set into the production lines.

However, such small forces have their uses. After many years of research, this principle of resonance has been applied to the design of a machine with which dynamic balance "couples" can be eliminated to a finer degree than has heretofore been thought possible. In operation, the machine magnifies small vibration as much as 50 times; consequently, when a condition of unbalance has been corrected to such a point that a vibration which has been amplified 50 times is practically eliminated, perfect balance of the rotating part is obtained with complete absence of vibration at high speeds.

The term "ounce-inch" has been accepted as the unit of measure of the force of dynamic unbalance. Thus one ounce-inch would be an unbalance force of one ounce at a one-inch radius. One-tenth ounce-inch would be one-tenth ounce at one inch radius, or one ounce at one-tenth inch radius. In the balancing of small series-wound armatures, the machine referred to corrects unbalance within an accuracy of 0.001 ounce-inch. If necessary, larger machines can work to a proportional accuracy.

The most difficult part of the problem is, of course, the locating of the heavy spots of unbalance for correction purposes, due to the changing relation of the high spot to the heavy spot, as noted on the curve, Fig. 5. However, if this location is always taken above the critical speed at a predetermined point, the lag can easily be controlled. In the machine shown in Fig. 6, a Neon light is used to locate the heavy spot. The Neon light, being cold light with no lag factor, is ideally suited to this use.

It is also used in the Stroboscope to stop motion at very high speeds.

The Neon light locator dial is indicated at **C**, Fig. 6. The light rotates in synchronism with the part to be balanced, which is rotated by the variable-speed reversible motor **R**. The Neon light is energized by the distributor in the flywheel **N**, which in turn receives its current from an external source of high voltage. As the workpiece is rotated, vibration is set up by the unbalanced condition and the light is flashed by contactors in the machine heads **P**, contact being made through vibration of the spring reed mounted bearings. The width of the light band produced is controlled by means of the screws **E**. Fixing of the location of the light band is done manually by means of the two indicators **M**, which are marked **R** and **L** to correspond to the right and left machine heads.

With the location of unbalance fixed on the locator dial, it is only necessary to stop the machine and bring the light back to the spot recorded on the dial. An arrow on the machine head locates the heavy spot for correction purposes accurately on either side of the part being balanced. One direction of rotation only is required to find this location, and the magnitude of unbalance is taken automatically at the time the location readings are taken. The entire operation of finding the location of unbalance on both sides of the part to be balanced and recording the magnitude of unbalance on both sides for correction purposes takes less than 30 seconds on small work.

In the foregoing, critical speed has been considered only as pertaining to the relation of mounting vibration to rotating speeds. Critical speeds are also encountered in the rotating parts themselves due to shaft deflection when rotated at high speeds. This condition is caused by unbalanced forces occurring in planes on long shafts which deflect the shaft or throw it out of the theoretical center and cause difficulty in correcting dynamically, as it is impossible to determine

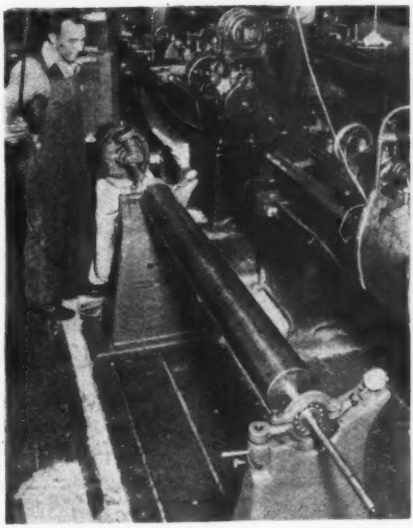


Fig. 10—Dynamically balancing a roll for a paper calendaring machine in the plant of the Champion Coated Paper Company.

the lateral planes in which these forces exist. They can usually be corrected by strengthening the shaft.

With a modern dynamic balancing machine it is possible for a manufacturer of machinery in which rotating parts are used to place his product on a 100 per cent dynamic balance basis. The time required to balance dynamically is in most cases no greater than the time required to balance statically, and there is no comparison in the results obtained.

In some cases special machines are required. In Fig. 7 is shown a special balancing machine for balancing automobile universal joint shafts, the

machine having an extra long bed and specially constructed heads. In Fig. 8 is shown a machine especially designed for balancing crankshafts.

An excellent example of progressive methods as applied to the dynamic balancing of motor armatures and rotors on a production basis is shown in Fig. 9. Here can be seen a section of the winding room in the plant of the Master Electric Company. All motors made in this plant are dynamically balanced, the dynamic balancing equipment being coordinated with modern conveying equipment. The hooks on the conveyor carry the armatures and rotors past the balancing machines, and during the time required for the conveyor hook to pass, the operator removes, balances, and returns the part to the same conveyor hook. Only by the use of modern balancing equipment would this be possible.

The necessity for the proper balancing of rotating parts in machines that are used in the manufacture of quality products is fast becoming recognized, as evidenced by the illustration Fig. 10. Here a mechanic is balancing a roll for a calendaring machine in the plant of the Champion Coated Paper Company.

Engineers and designers of new machines should so design their products that provision can be made in the design to permit correction for dynamic unbalance, if the design incorporates rotating parts that are to operate at high speeds. A small flange can be provided, or holes can be provided for adding rivets or weights. A little thought applied to design will save countless dollars in production costs. The dynamic balancing machines now available are accurate; they are adapted for the balancing of all products—large or small, and the amount of time required in the balancing operation is reduced to the minimum. The bulk of the time is consumed in making the correction, and this time can be reduced by proper design.

"Improved Methods of Industrial Metal Degreasing"

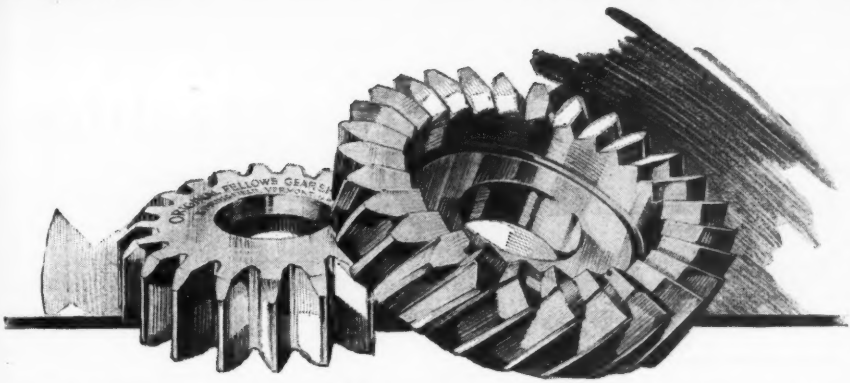
The Dow Chemical Co., Midland, Mich., has issued a booklet in which the subject of the "degreasing" of metals is discussed in detail. The booklet is prepared to supply data for which this company has frequent demand, and makes available to all who may be interested the expert advice and fund of information that has been gathered by laboratory research.

In the chapter on "Method of Metal Degreasing Using Organic Solvents," the subjects of liquid phase degreasing and vapor phase degreasing are discussed in turn. Following is a discussion in which the factors of solvent action, fire hazard, toxicity, boiling point, solubility in water and ease of separation from water, latent heat of vaporization and specific heat, specific gravity, and corrosion are analyzed. Included is a two-page drawing showing the general method of construction of a tank for metal degreasing, and tables in which comparisons are made between the various properties of various degreasing agents.

A copy of the book can be had by any plant executive who will address the above company on his firm letterhead.

Bulletin Describes Redesigned Line of Kron Automatic Industrial Scales

The Kron Company, Bridgeport, Connecticut, is distributing a bulletin that describes the complete line of Kron Automatic Industrial Scales, which have been completely redesigned. Included among the scales described and illustrated are dial track scales, portable pan, portable platform, dormant platform, bench, hopper, crane and pitless suspension types. Each type has been completely redesigned, improved and strengthened, and the dial and lever mechanism has been simplified.



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FELLOWS
GEAR SHAPERS

Time Setting in a Machine Tool Plant—

By F. K. MANDER

Where Wide Variety and Small Quantities Make Individual Time Studies Impracticable

THE problem of setting just and equitable time standards in plants engaged in jobbing or machine tool work where designs are in a state of transition presents serious difficulties. The wide variety of work and comparatively small quantities make individual time studies expensive and impractical. Furthermore, the standard time must usually be set previous to the job, for both quotation and production planning purposes.

The writer presents in this article methods devised to meet these conditions which have been used with some degree of success in a well-known machine tool plant. The basic idea is the study of work and machines by classes, and the development of simple and flexible time setting charts. These charts do not always specify the best conditions for some particular jobs, but they constitute a marked improvement over the former practice of dependence upon the judgment of the foreman or operator. By using these charts, standard times have been set systematically, with a variation of 2 per cent to 5 per cent from the actual time used.

As an illustration of the way these time setting charts are developed and used, the specific case of setting time for hobbing spur and helical gears will be considered. The work covered in the preparation of these charts included the cutting of both straight and helical spur gears, varying from 4 to 24 diametrical pitch, steel and cast iron, any length of face, and with round, square and spline bores, both clean and copper plated. These gears were for the most part used on high grade machine tools, and it was necessary therefore to maintain a high standard of workmanship, both as to the appearance of the tooth surface and the running qualities of the gear. Where gears are produced in large quantities and where such high standards are not required, the speeds and feeds specified in these tables can no doubt be considerably increased. The machines used consisted of a battery of No. 12 Barber-Colman hobbers, with ground hobs of standard manufacture.

The time setting charts on the hobbing work are based on time studies taken on a wide range of jobs. Each job was studied for the best condition of speed and feed, the handling time checked against similar jobs, and finally the charts were made up from the accumulated data. A sample time study is shown in Fig. 1. The Rate Table was made up on eight

sheets, which are shown in Figs. 2, 3, 4, 5, 6, 7, 8, and 9, and its development will be taken up in detail.

The "Instructions for Rate Setting," Fig. 2, is a reference sheet for the use of new men coming into time study work, and simply an instruction sheet for the entire rate table, with a sample comparison.

The "Set-up Times" sheet, Fig. 3, shows the time allowed and the sequence of operations for the various set-ups. While all the operations listed are not necessary in every set-up, it is obviously impracticable to set the standard time more closely to cover these specific jobs. For example, when setting up a new job, the arbor previously in the machine may be used, or it may be that all of the gearing changes specified may not be necessary. A method of determining the set-up more accurately by eliminating this condition is now being worked out.

The "Handling Time" sheet, Fig. 4, shows four different sequences; roughing and finishing with a single lead hob, with or without feed change, roughing with a double lead roughing hob and finishing with a single lead finishing hob, and, finally, roughing and finishing in one cut. The following sheet, Fig. 5, shows further data. Where a speed change is required between cuts, 1.50 minutes are added to the total handling time. The chucking and removing time is given in a separate table, as it is independent of the method of cutting. This table shows the chuck-

TIME STUDY SHEET— WORKS

| | | |

ing and removing time for any number of gears cut at a time, according to the kind and condition of the bore.

TIME SETTING CHART ①
Barber Colman Hobbers.

INSTRUCTIONS FOR RATE SETTING
STRAIGHT SPUR GEARS

1- From drawing, note length of face, pitch, No. teeth, and hob.

2- Refer to table "C", page 4, and determine No. of cuts and method of cutting.

3- Refer to page 2 for SET-UP TIME.

4- Refer to table "D" page 4, for No. of blanks per chucking.

5- Determine O.D. of hobs from Hob List, page 7.

6- Select proper speed (page 7) and feed (page 6) for each cut.

7- Determine allowed overtravel on each cut from table "E", page 5.

8- Figure time for each cut, using formula, table "F", page 5.

9- Determine Total Handling Time per chucking, pages 3 & 4.

10 Add 5% to Total Base Time (sum of handling & chucking time)

11 Divide Total Allowed Time by number per chucking.

This gives Net Time per Piece

Example- 50pcs.10P 1"face, 50T, plain spur (1 "rd,Bore) SAE 2315

1- Face 1.00";P 10;N 60; Hob-S10RD (roughing) & S10R (finishing)
2- No cuts- 2. Rough with double lead hob S10RD.
3- Set-up time - 80.00 Min.
4- 3 blanks per chucking.
5- S10RD - 2.69" O.D. S10R - 2.756" O.D.
6- Roughing - 110R.P.M. .060" feed. Finish - 161R.P.M. - .045" feed.
7- Allowed overtravel. Rough - .74" Finish - .125"
8- Cutting-

Roughing-	60x3.74 110x.060x2	17.0 Min.
Finishing-	60x3.125 161x.045x1	25.8 Min.
	Total	42.8 Min.

9- HANDLING TIME 5.06 Min.

10 1.05 (5.06 42.8) 50.25 Min.

11 NET TIME PER PIECE 50.25 16.75 Minutes.

Fig. 2—The Rating Table is made up on eight sheets, including the above "Instructions for Rate Setting" and the sheets shown as Figs. 3, 4, 5, 6, 7, 8, and 9.

It was found that chucking time varied somewhat with different types of bore (i. e., splined, square, round, and so on), but was affected to an even greater extent by the condition of the bore. If a gear was as it left the machines from previous operations, it usually went on the arbor easily and the chucking time was small. However, it is frequently desirable to case harden only the tooth surface, and the blank is copper-plated before cutting so that when it is pack-hardened, only the surface where the plating has been removed is affected. This copper plating, of course, coats the bore in a slightly uneven manner, which it was found increased the chucking time.

The "Method of Cutting," Table C, Fig. 5, depends upon the pitch, material and quantity of order. As the table shows, it is not efficient to use double lead roughing hobs for orders of less than 30 pieces, as the time required to change hobs more than offsets the time saved through faster cutting. Also, since the difficulties of lining up the teeth increase as the tooth thickness decreases, gears over 10 D. P. are not roughed with a double lead hob.

The "Number of Gears per Chucking," as shown in Table D, is for gears without hubs only. In some cases it is possible to cut a longer length of face than specified, but for small lots this is not practicable. For gears with hubs, each case must be considered individually, and it is difficult to lay down a hard and fast rule. Where the hub projection is very small, perhaps $\frac{1}{16}$ in. or $\frac{1}{8}$ in., it may be good practice to chuck more than two at a time, but usually gears with one hub and

(Continued on page 80)

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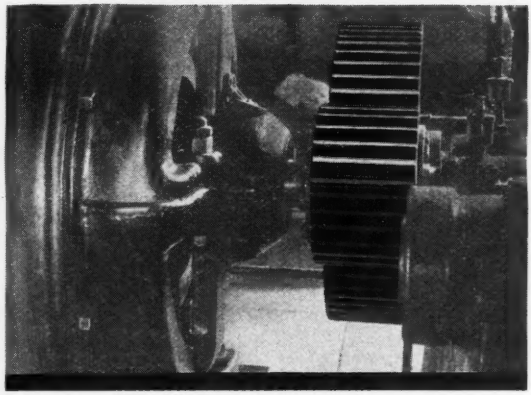

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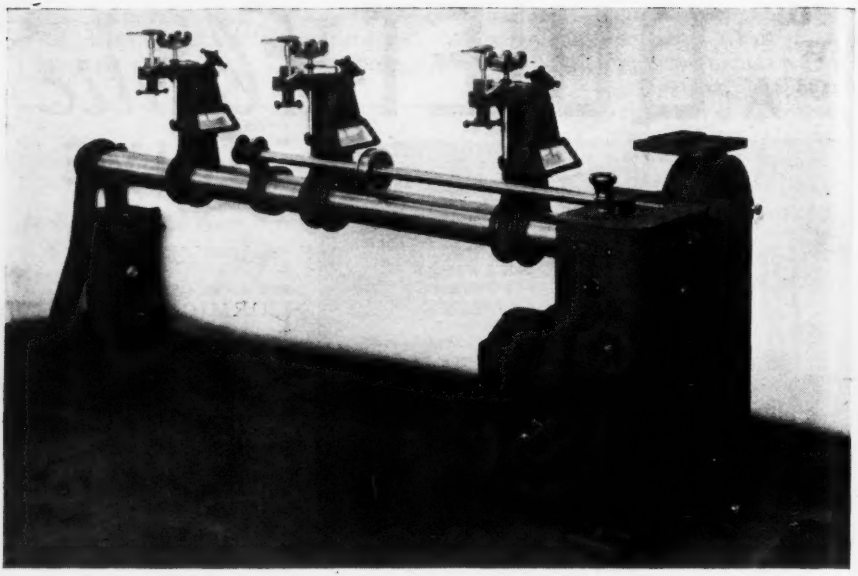
FORMICA *Non-Metallic* GEARS

THE FORMICA INSULATION COMPANY, 4640 Spring Grove Ave., Cincinnati, Ohio



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The work supports of the Norton Running Balance Indicating Machines weigh only 1½ pounds each complete, thus minimizing their inertia and permitting very small centrifugal forces to manifest themselves. It is the most sensitive, the simplest and the least expensive balancing machine on the market.

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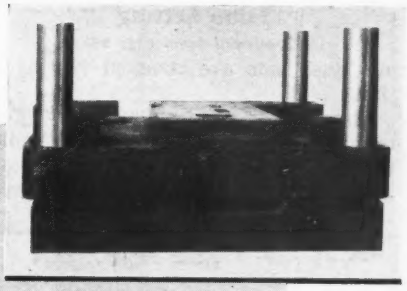
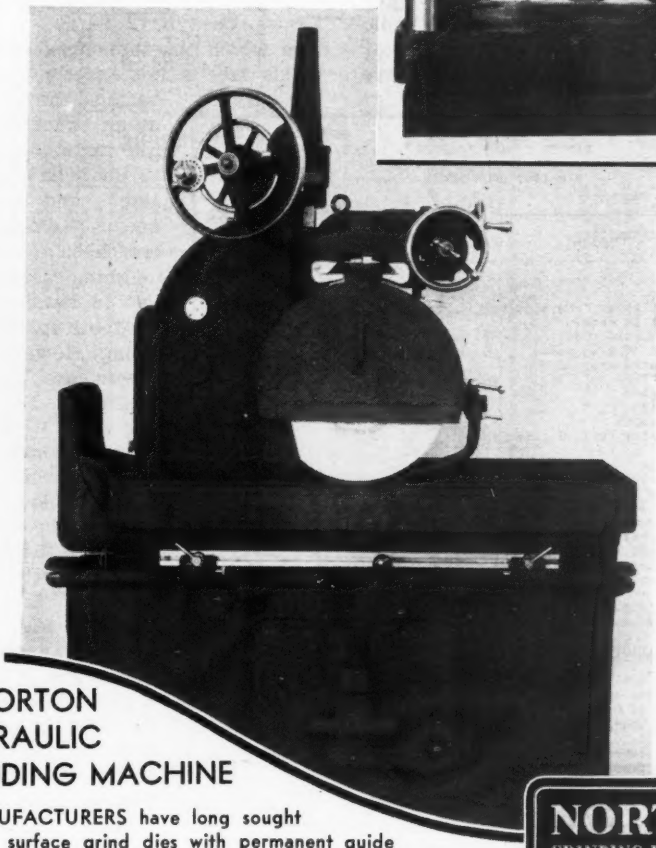
FOR SURFACING DIES WITHOUT REMOVING GUIDE POSTS





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MANUFACTURERS have long sought to surface grind dies with permanent guide posts. The operation is now practicable—there is a Norton 10 x 12" Surface Grinder to handle this class of work.

Dies can be maintained in better condition because the operation of regrinding them is easier and more economical and can therefore be performed more often. New dies can be surfaced more quickly than by previous methods and at less cost.

The machine is hydraulically operated and can be furnished with an automatic cross feed, also hydraulically operated, if desired. In every detail it is a fast, accurate and well built machine. Information will be gladly sent upon request —no obligation.

NORTON GRINDING MACHINES

NORTON COMPANY
Worcester, Mass.

M-306

Time Setting

(Continued from page 26)

one flush side are chucked two at a time.

The "Overtravel Allowance" for roughing cuts, shown in Fig. 6, Table E, is figured from the hob diameter and full depth, or pitch, since there

TIME SETTING CHART — MACHINES
BARBER COLMAN HOBBERS — #1063, 1544, 1178, 1551, 1572
STRAIGHT SPUR GEARS

A-SET-UP Time.

OPERATIONS	Rough & finish with same hob	Rgh. with rgh hob Finish with fin. hob
1- Ring clock, get drawing	2.00	2.00
2- Remove hob	.60	.60
3- Get hob & arbor from toolcrib	4.00	4.00
4- Place hob in mach.	2.00	2.00
5- Set helix & and check	1.00	1.00
6- Place and true up arbor	6.00	6.00
7- Change index gearing	1.50	1.50
8- Check " "	2.65	2.65
9- Change speed "	.75	.75
10 Change feed "	1.50	1.50
11 Set for depth	.75	.75
12 Try for size (avg. 3 trial cuts)	12.00	12.00
13 Ring clock	-	2.00
14 Remove hob	-	.60
15 Place hob	-	2.00
16 Set helix & and check	-	1.00
17 Change index gearing	-	1.50
18 Change speed "	-	.75
19 Change feed "	-	1.50
20 Set for depth	-	.75
21 Trial cuts (adjust index)	-	5.00
TOTAL SET-UP ALLOWANCE-	35.00 Min.	50.00 Min.

HOB CHANGE ALLOWANCE

1- Remove hob	.60
2- Place hob in mach.	2.00
3- Set helix & and check	1.00
4- Change index gearing	1.50
5- Check "	2.65
6- Change speed "	.75
7- Change feed "	1.50
8- Trial cuts	5.00
TOTAL	15.00 Minutes

Fig. 3—The "Set-Up Times" sheet shows the time allowed and the sequence of operations for the various set-ups.

is a definite ratio between the two. This condition is the same as with a milling cutter. When the cut starts, the hob and work are in the relation shown at A in Fig. 10. Then the cut progresses, the hob reaches the full depth. The hob and work are then in the relation shown at b in Fig. 10. The dimension "O" is the distance traveled by the hob when the cut reaches full depth, which can be determined by right triangles.

$$R^2 = O^2 + (r - h)^2$$
$$r^2 = O^2 + r^2 - 2\,rh + h^2$$
$$O^2 = 2\,rh - h^2$$
$$O = \sqrt{h\,(2r - h)}$$

from which the table was computed.

This law is not exactly true, first because the hob is not at an exact right angle to the work (due to the helix angle setting) and secondly, because when single lead hobs are used for roughing there is stock left in the bottom of the tooth space for finishing. However, these errors are relatively negligible. For finishing cuts, ⅛ in. overtravel is allowed. This figure is arbitrary and simply allows clearance at the start and finish of the cut.

The "Cutting Time Formula" is given in Table F, Fig. 6. The hobbing process involves a hob threaded a given lead which is rotated in conjunction with a gear blank at a ratio dependent upon the number of teeth to be cut. The cutting action is continuous, and each complete revolution of the work advances the hob a distance over the face of the gear equal to the feed, the indexing being automatic and continuous. The formula is derived as follows:

The number of teeth in the gear, divided by the lead of the hob, equals the revolution of the hob for one revolution of the work.

TIME SETTING CHART
BARBER COLMAN HOBBERS ③

B-HANDLING TIME- STRAIGHT SPUR GEARS

PROCEDURE	Rough & finish S.L. hob With feed change	Rough & finish S.L. hob No feed change	Rgh. with rgh. hob. finish with fin. hob	Rough & finish in one cut
1- Walk to machine	.20	.20	.20	.20
2- Carriage back	.15	.15	.15	.15
3- Loosen arbor nut	.09	.09	.09	.09
4- Loosen and back steady rest	.08	.08	.08	.08
5- Remove arbor nut	.12	.12	.12	.12
6- Remove - gears				
7- Chuck - Blanks				
8- Set nut on arbor	.20	.20	.20	.20
9- Advance arbor steady rest	.12	.12	.12	.12
10- Tighten nut on arbor	.10	.10	.10	.10
11- Loosen overarm nut	.06	.06	-	-
12- Loosen 4 nuts on upright	.14	.14	-	-
13- Set Depth	.15	.15	-	-
14- Tighten 4 nuts on upright	.15	.15	-	-
15- Tighten overarm nut	.11	11	-	-
16- Change feed gearing	1.50	-	-	-
17- Start machine	.08	.08	.08	.08
18- Feed in by hand	.10	.10	.10	.10
19- ROUGH CUT	M	M	M	M
20- Walk to machine	.20	.20	.20	-
21- Carriage back	.15	.15	.15	-
22- Loosen arbor nut	-	-	.09	-
23- Loosen and back steady rest	-	-	.08	-
24- Centerpunch gears	-	-	.33	-
25- Remove arbor nut	-	-	.12	-
26- Remove - gears	-	-	-	-
27- Chuck - gears & lineup	-	-	.20	-
28- Set nut on arbor	-	-	.20	-
29- Advance arbor steady rest	-	-	.12	-
30- Tighten nut on arbor	-	-	.10	-
31- Loosen overarm nut	.06	.06	-	-
32- Loosen 4 nuts on upright	.14	.14	-	-
33- Set Depth	.15	.15	-	-
34- Tighten 4 nuts on upright	.15	.15	-	-
35- Tighten overarm nut	.11	11	-	-
36- Change feed gearing	1.50	-	-	-
37- Advance hob & set index	-	-	1.00	-
38- Start Machine	.08	.08	.08	-
39- Feed in by hand	.10	.10	.05	-
40- FINISH CUT	M	M	M	-
Plus hob change allowance	.30	.30	.30	.30
Total handling time per chucking	6.29	3.29	4.26	1.54
" " " - Roughing		1.90		
" " " - Finishing		2.36		

Note- See next sheet before using this table-

Fig. 4—The "Handling Time" sheet shows four different sequences of operations in the machining of spur gears.

TIME SETTING CHART
BARBER COLMAN HOBBERS ④

B-HANDLING TIME-STRAIGHT SPUR GEARS - (cont)

Use following table for loading & unloading elements.
N.B.-This time to be added to Total Handling Time.

BORE	CHUCKING First Gear	CHUCKING Second Gear	CHUCKING Each add gear	REMOVING Any no.
1- Square bore- clean	.08	.08	.08	.10
2- " " copperplated	.25	.20	.10	.25
3- Round " clean	.10	.10	.10	.10
4- " " copperplated	.25	.20	.10	.20
5- Spline bore	.10	.08	.08	.20

NOTE- #2- When speed gearing must be changed between cuts add 1.50 Min. to Total Handling Time

C- METHOD OF CUTTING

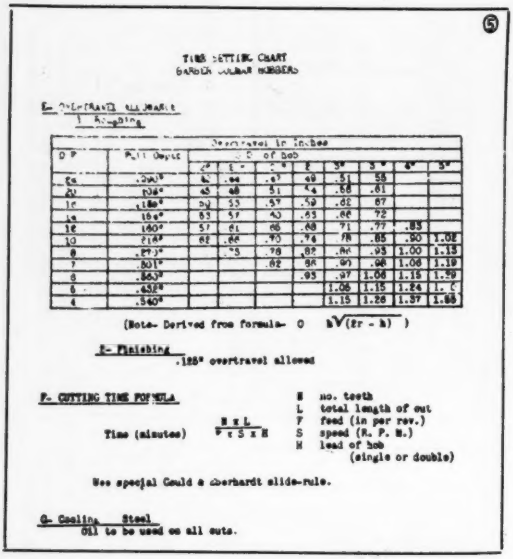
MATERIAL	STEEL				C.I.	
PITCH	Under 30 pcs. 1st cut	Under 30 pcs. 2nd cut	30 pcs or over 1st cut	30 pcs or over 2nd cut		
over 16 P	S.L	-	S.L		all pitches one cut	S.L. Single lead hob
16 P & under except	S.L.	S.L.	S.L.	S.L.	S.L. hob	D.L. double lead hob
10 P	S.L.	S.L.	D.L.	S.L.		
8 P	S.L.	S.L.	D.L.	S.L.		
6 P	S.L.	S.L.	D.L.	S.L.		
5 P	S.L.	S.L.	D.L.	S.L.		
4 P	S.L.	S.L.	D.L.	S.L.		

D- NUMBER OF GEARS PER CHUCKING
Gears without hubs
Length of face- 1" or over - 3 per chucking
13/16" to 1" - 4 " "
3/8" to 3/4" - 5 " "
1/4" to 5/16" - 6 " "
under " - 7 or more"

Fig. 5—Table B is a continuation of the handling time data. The "Method of Cutting," Table C, depends upon the pitch, material, and quantity on order. Table D gives the number of gears per chucking, for gears without hubs only.

$\frac{N}{H}$ = Rev. of hob per rev. of work.

The revolutions of the hob per revolution of the work, divided by the revolutions per minute of the hob, equals the minutes per revolution of the work.



TIME SETTING CHART
GARDNER GULLAR MEMBERS

E- Overtravel Allowance
1 Roughing

D P	Full Depth	Overtravel in Inches — No. of Rod							
		2"	2½"	3"	3½"	4"	4½"	5"	5½"
24	.208"	42	44	47	49	.51	.53		
20	.204"	45	48	51	.54	.56	.61		
16	.188"	50	53	.57	.59	.62	.67		
14	.154"	53	57	.60	.63	.66	.72		
12	.160"	57	.61	.65	.68	.71	.77	.83	
10	.216"	.62	.66	.70	.74	.78	.85	.90	1.02
9	.227"		.75	.78	.82	.86	.93	1.00	1.13
7	.301"			.82	.86	.90	.98	1.06	1.19
8	.343"				.93	.97	1.06	1.15	1.29
6	.432"					1.06	1.15	1.24	1.40
4	.540"					1.15	1.26	1.37	1.55

(Note- Derived from formula- $O \quad h\sqrt{(2r - h)}$)

F- Finishing
.125" overtravel allowed

F- CUTTING TIME FORMULA

Time (minutes) $\frac{N \times L}{F \times S \times H}$

N no. teeth
L total length of cut
F feed (in per rev.)
S speed (R. P. M.)
H lead of hob (single or double)

Use special Gould & Eberhardt slide-rule.

G- Cooling Steel
Oil to be used on all cuts.

Fig. 6—Table E gives the "Overtravel Allowance," and Table F comprises the "Cutting Time Formula."

$\frac{(N)}{(H)}$ = Minutes per rev. of work.

$\overline{S}$

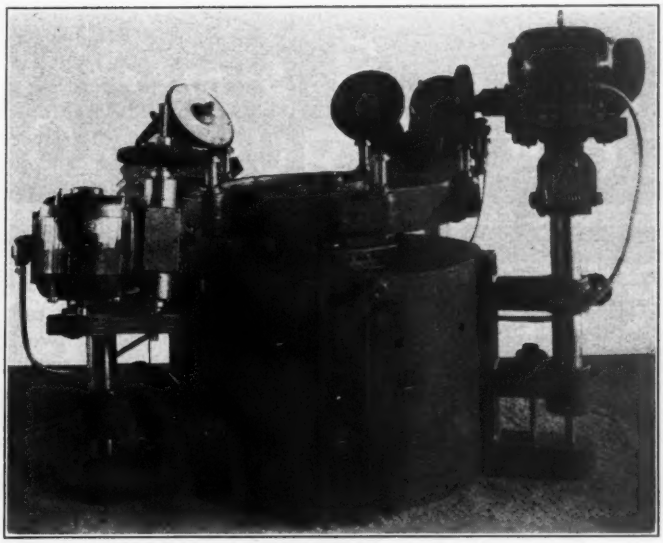
Also the total length of cut (length of face plus overtravel) divided by the inches feed per revolution of work equals the total number of revolutions of the work required.

$\frac{L}{F}$ = Number of rev. of work required.

Therefore, the cutting time is equal to the number of revolutions required, multiplied by the minutes per revolution.

$$\text{Cutting Time} = \frac{L \times \frac{(N)}{(H)}}{\frac{F}{S}} = \frac{N \times L}{F \times S \times H}$$

The standards for feeds and speeds as shown on the sheets given as Figs. 7 and 8 represent the best conditions for high grade machine tool work, as previously stated, and are the results of considerable experimental work. The speed and feed on each job studied were varied until the best possible combination was found. After a number of jobs had been studied the tables were made up, and have been used for several months without change. These sheets are posted on the machines and give the operator sufficient instructions so that special instruction cards are required on comparatively few jobs. When a new job is set up, the operator first consults the "Feed Table" and selects the proper feed, according to the material, the pitch, and the hob specified on the operation sheet. The operation sheet serves as a route tag, listing the operations in the correct sequence, the tools, and the standard time allowed for set-up and per piece. The second part of the Feed Table shows the feed gears which will give the desired feed. This done, he determines the hob diameter by reference to the Hob List (No. 1, Fig. 8), or by measurement, then refers to the Speed and R. P. M. Table (No. 2), where the proper R. P. M. is shown for the specific conditions of material, cut, and hob diameter. He then refers to the Speed Change Gear



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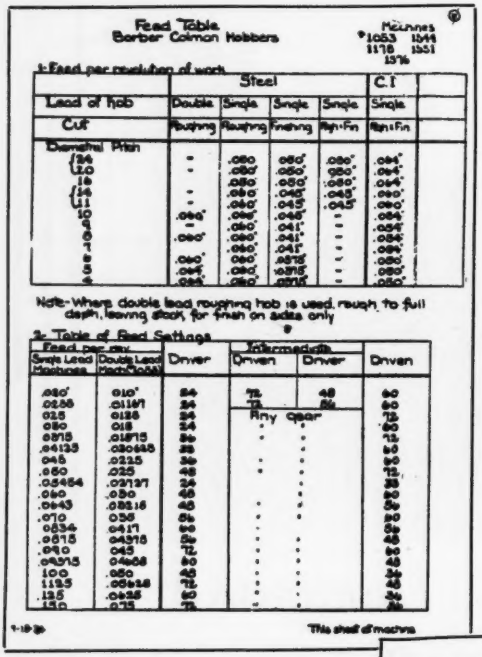

Feed Table
Barber Colman Hobbers

Machines
*1053 1044
1178 1551
1576

1-Feed per revolution of work

Lead of hob	Steel				C.I.	
	Double	Single	Single	Single	Single	
Cut	Roughing	Roughing	Finishing	Rgh.-Fin.	Rgh.-Fin.	
Diametral Pitch						
24	-	.020"	.020"	.020"	.004"	
20	-	.020"	.020"	.020"	.004"	
16	-	.020"	.020"	.020"	.004"	
14	-	.020"	.020"	.020"	.020"	
11	-	.020"	.020"	.020"	.020"	
10	.020"	.020"	.020"	-	.020"	
9	-	.020"	.041"	-	.020"	
8	.020"	.020"	.041"	-	.020"	
7	-	.020"	.041"	-	.020"	
6	.020"	.020"	.020"	-	.020"	
5	.020"	.020"	.020"	-	.020"	
4	.020"	.020"	.020"	-	.020"	

Note-Where double lead roughing hob is used, rough to full depth, leaving stock for finish on sides only

2- Table of Feed Settings

Feed per rev. Single Lead Hobs	Feed per rev. Double Lead Hobs	Driver	Intermediate Driven	Intermediate Driver	Driven
.020"	.010"	24	72	48	60
.0238	.01187	24	72	56	60
.025	.0125	24	Any gear		72
.030	.015	24	"	"	60
.0375	.01875	24	"	"	48
.04125	.020625	24	"	"	40
.045	.0225	24	"	"	60
.050	.025	48	"	"	72
.05454	.02727	24	"	"	33
.060	.030	48	"	"	80
.06433	.03216	48	"	"	56
.070	.035	24	"	"	30
.0834	.0417	60	"	"	40
.0875	.04375	28	"	"	48
.090	.045	72	"	"	80
.09375	.04688	60	"	"	48
.100	.050	48	"	"	24
.1125	.05625	72	"	"	48
.125	.0625	60	"	"	24
.130	.075	72	"	"	24

This shall of machine

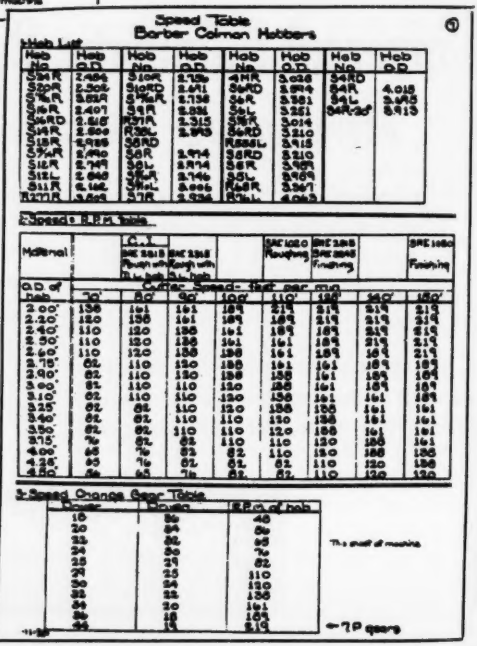
Fig. 7 (Above) and Fig. 8 (Right)—The standards for feeds and speeds as shown on these two sheets are the result of considerable experimental work.

Table (No. 3) for the proper change gears. This plan of leaving the selection of the proper feed and speed change gears to the operator has been successful, but a plan to specify the proper feed and speed on the operation sheet is being worked out. Thus the problem of supervision over the hobbing machines is simplified, eventually resulting in a reduction of the supervision expense.

The data for the cutting of helical spur gears is much the same as for the straight type spur gears and is given on the sheet shown as Fig. 9. The handling time is somewhat longer. The standard roughing speeds are used for finishing as well, and the feed varies from the straight spur feed as shown (Gould & Eberhardt Standard).

The standard times on these jobs are used for production planning, quotation, and general supervisory purposes. All work on the hobbing machines being on a strictly day work basis, a rest and delay allowance of 5 per cent is added to the base time. Should this work ever be placed on a piece work or bonus system, the only changes necessary will be a revision of the rest and delay allowances.

The use of the charts is illustrated in Fig. 2 as for a gear of 10 diametrical pitch, 1-in. face, and so on. To give a further illustration; required, the standard time for cutting a


Speed Table
Barber Colman Hobbers

1-Hob List

Hob No.	Hob O.D.	Hob No.	Hob O.D.	Hob No.	Hob O.D.	Hob No.	Hob O.D.	Hob No.	Hob O.D.
3SHR	2.484	3SHR	2.738	4HR	3.628	5HRD			
3SHR	2.566	3SHRD	2.841	4HRD	3.894	6HR	4.018		
3SHR	2.858	3SHR	3.138	5HR	3.981	6HR	3.945		
3HR	2.407	3HR	2.836	5HR	3.251	6HR/20°	3.913		
3HRD	2.665	3HR	2.315	5HR	3.014				
3HR	2.866	3HR	2.893	5HRD	3.210				
3HR	2.4799	3HRD		R5HRD	3.418				
3HR	2.490	3HR	2.914	5HRD	3.210				
3HR	2.749	3HR	2.914	5HR	3.498				
3HR	2.862	3HR	2.746	5HR	3.489				
3HR	2.166	3HR	2.866	R5HR	3.267				
R3HR	2.866	3HR	2.334	R5HR	4.043				

2-Speeds R.P.M. Table

Material	C.I.				SAE 1020 Roughing	SAE 1045 SAE 3240 Finishing		SAE 1020 Finishing
	SAE 3215 Rough with Hob Sh. Hob	SAE 3245 Finish with Hob Sh. Hob						
O.D. of Hob	Surface Speed-feet per min.							
	70'	80'	90'	100'	110'	120'	140'	160'
2.00"	138	161	184	207	219	219	219	219
2.20"	126	146	167	188	199	219	219	219
2.40"	115	134	153	172	182	192	219	219
2.60"	106	123	141	159	168	177	199	219
2.80"	98	115	131	147	156	164	184	205
3.00"	92	107	122	138	146	153	172	191
3.20"	86	100	115	129	136	143	161	179
3.40"	81	94	108	121	128	135	151	168
3.60"	77	89	102	115	121	128	143	159
3.80"	73	84	96	108	115	121	135	151
4.00"	69	80	92	103	110	115	129	143
4.25"	65	76	87	97	103	110	122	136
4.50"	61	71	82	92	97	103	115	129

3-Speed Change Gear Table

Driver	Driven	R.P.M. of hob
16	80	48
20	64	80
22	32	88
24	80	72
28	28	82
24	25	110
20	24	120
22	22	132
24	20	144
24	18	160
24	16	176

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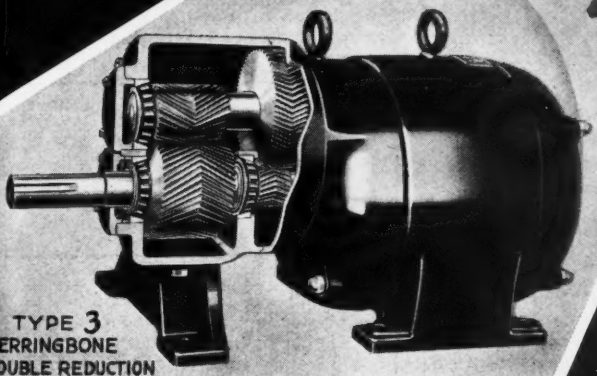

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TIME SETTING CHART
BARBER COLMAN HOBBERS

HELICAL SPUR GEARS

A- SET-UP
As for straight spur gears.

B- HANDLING TIME
As for straight spurs plus 5.50 minutes per chucking.

Always roughed and finished with same hob.
No speed changes between cuts
No feed changes between cuts

C- OVERTRAVEL
Roughing
Overtravel as for straight spurs + .25"

Finishing
.25" overtravel allowed

D- SPEED
Use roughing speeds for straight spurs
(No speed changes between cuts)

E- FEED
Oculo & Eberhardt Standard

Helix angle - 0°-36° - As straight spur finishing feeds
" " 36°-48° - 3/4 x " " " "
" " 48°-60° - 5/8 x " " " "
" " 60°-70° - 1/2 x " " " "
" " over 70° - 3/8 x " " " "

Fig. 9—Data for the cutting of helical gears.

gear with the following specifications:

15 pcs. 16 D. P. ¾-in. face, no hubs, 40 T, plain spur, 1⅛-in. round clean bore, SAE 1020 steel, Hob, S16R.

Following the sequence as in (Figure 2) Sheet No. 1.

1.—Face = .75 in., D. P. = 16, N = 40 — Hob S 16R.
2.—Two Cuts—S. L. Hob.
3.—Set-up Time = 35.00 Minutes.
4.—5 Blanks per chucking.
5.—Hob S-16-R—O. D. = 2.407 in.
6.—(Roughing—Speed = 189 R. P. M. Feed = .050 in. per revolution.
(Finishing—Speed = 219 R. P. M. Feed = .050 in. per revolution.
7.—(Roughing O.T. = .56 in.
(Finishing O.T. = 1.25 in.
8—Cutting Time

$$\text{Roughing} = \frac{40 \times 4.31}{.050 \times 189 \times 1} = 18.24$$

$$\text{Finishing} = \frac{40 \times 3.875}{.050 \times 219 \times 1} = 14.16$$

Total = 32.40 Minutes

9.—Total time for chucking (Rgh. & Fin. with S. L. Hob, no feed change), 3.29.

Chucking Time (5 blanks; .10 Min. ea.), and Removing (any no.: 10 Min.), .60.

Changing speed gears, 1.50.

Total handling time per chucking, 5.39.

10.—Total time allowed per chucking = 1.05 (5.39 + 32.40) = 39.68 Minutes.

11.—Time per piece $= \frac{39.68}{5} = 7.49$ Minutes per piece

Plus 35.0 Min. Set-up. Total Standard Time = 154.1 Minutes.

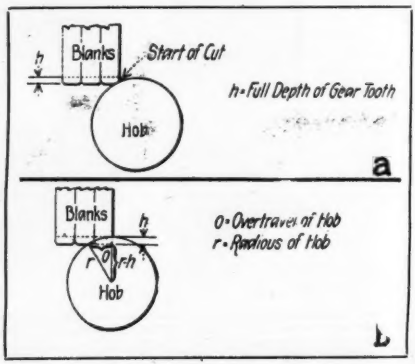

Fig. 10—Showing, at "a," the relation of the hob and work at the start of the cut and, at "b," the relation of the hob and work as the hob reaches the full depth of cut.

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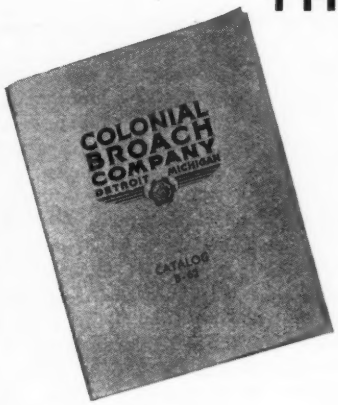
THIS *New 90-Page Catalog*



JUST off the press has come this New Colonial Broach Catalog, B-62. It is a complete reference book on modern broaching equipment, which every user of broaches will find valuable and useful.

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STAMPINGS

Small & medium stampings in a complete range of materials & finishes for general & special use. A 17-year old die department, specialized to produce accurate tools for your stamping requirements.

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IDEAS FROM READERS

This department is a clearing house for ideas . . . If there is a "kink" or short cut in use in your shop, send in a description of it . . . We will pay for each one published.

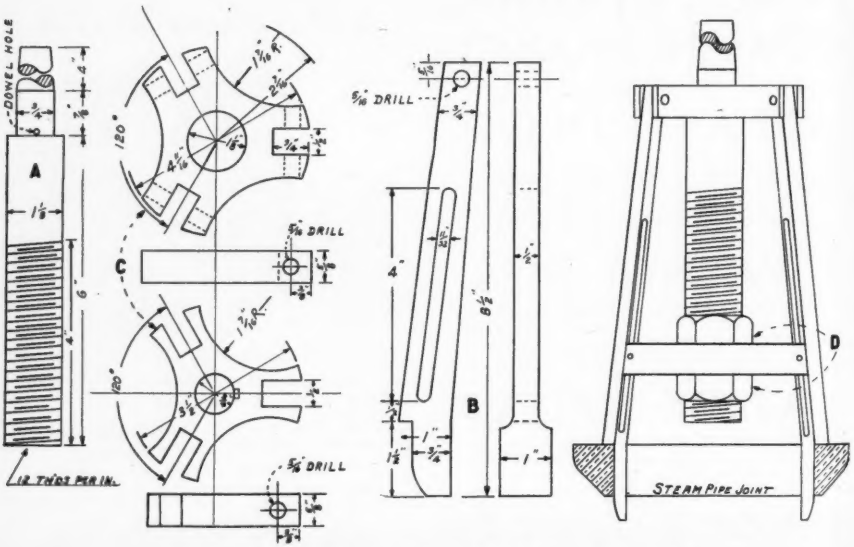
Adjustable Steam Pipe Joint Grinding Mandrel

By H. H. HENSON

THE accompanying illustration shows the design of a very useful tool for grinding-in steam pipe joints on a locomotive. This operation is still being done by hand in most locomotive shops, or by the use of wooden blocks, and anyone who has performed this task knows what a difficult and tiresome operation it is.

The tool consists of a spindle **A**, the three legs **B**, two spiders **C**, and two nuts **D**. The spindle **A** carries a No. 4 Morse taper to fit the sleeve in an air motor. The smaller spider is doweled to the spindle just above the shoulder, making it stationary, and the larger spider is locked at any desired position on the spindle by locking the two nuts **D**.

The feature of the tool is the fact that the legs can be adjusted to fit the pipe. All that is necessary to fasten the tool to a joint ring is to loosen the nuts **D**, run them up or down to obtain the required size, and tighten them again. With an air motor applied to the shank of the tool, it is ready to be applied for the grinding operation.



Details of Adjustable Steam Pipe Joint Grinding Mandrel

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116 sizes of Cored and Solid Bars of Phosphor Bronze always in stock.

A special alloy Lead Base Babbitt of surprising and valuable superiority.

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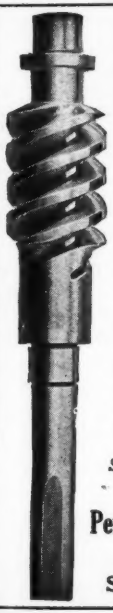

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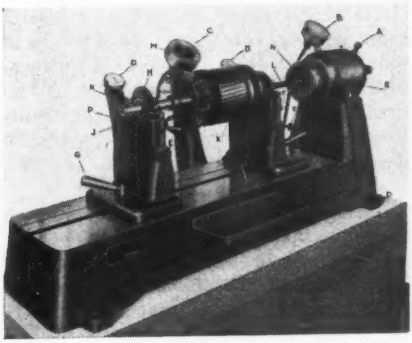

NEW FEATURES

No crayons or pencils used to find location of unbalance: Location of unbalance recorded instantly by ELECTRICAL DEVICE.

Dial "C" shows location of unbalance on either side of work.

Magnitude of unbalance recorded automatically on Dials "D" while location readings are taken.

These New Machines Dynamically Balance to an accuracy heretofore considered impossible.

Built in sizes to handle work from 1" to 96" in diameter; for weights from ¾ ounce to 10,000 pounds.

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401 DAVIS AVENUE DAYTON, OHIO

Mfrs. of Special Machinery, Die Castings, Static and Dynamic Balancing Machines, Armature Winding Machines.

Simple, But Accurate, Angles

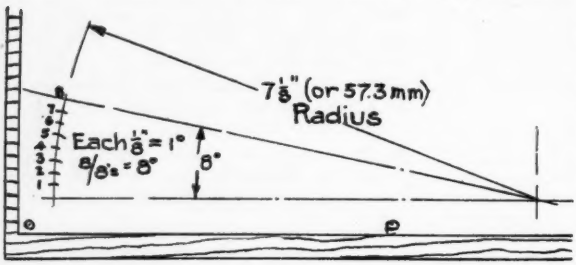
By MORRIS A. HALL

IT sometimes happens that, at the particular moment when an angle must be laid out in degrees, no protractor is available. In such a case, the method described here may be used with quite satisfactory results.

On a sheet of paper or cardboard draw a base line, and from a given point on this line lay off a circle of 57.3 mm. radius. On this radius, the circle will have a diameter of 360.02 mm., so that each mm. of the circle will equal a 1-deg. angle, with a negligible error. On such a circle the draftsman then lays off as many millimeters as there are degrees in the desired angle; 8 mm. for 8 degrees, and so on.

If it is desired to use the English measure instead of the metric system, ⅛ in. may be taken as the unit of measurement, in which case a circle is drawn 7⅛ in. diameter plus 3/19 of ⅛ inch. Such a circle will have a circumference of practically 360 eighth-inches, so that each ⅛ in. laid off on such a circle subtends an angle of 1 degree. Consequently, as many eighth-inches are laid off as there are degrees in the angle required.

On a circle of 57.3 mm. radius,



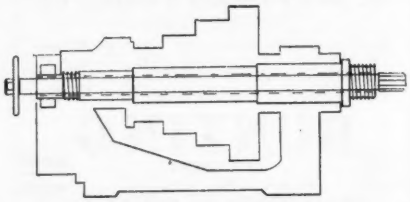
Laying off angles without a protractor

each millimeter equals 1 degree; on a circle of 7⅛ in. plus, each eighth-inch equals 1 degree. For closer accuracy or for larger work, a radius of 14¼ in. plus 3/10 of ¼ in. may be used, for which each ¼ in. equals 1 degree.

Reaming Through the Headstock Spindle

By CHARLES R. WHITEHOUSE

ON small lots of work that have to be bored and reamed, we have found that a great deal of time can be saved by inserting a reamer bar through the headstock spindle of the



Cross section drawing showing how reamer is used through headstock spindle of engine lathe

engine lathe and reaming the work from the rear. This method is, of course, economical only on small lots where time would be consumed in setting up a turret lathe, or when a turret lathe is not available.

The tool consists of a bar that is approximately 8 in. longer than the core in the headstock spindle, and is about 0.010 in. smaller than the spindle hole. One end of the bar is machined to hold a shell reamer; the other end is threaded to hold a hand wheel of 10 in. diameter. The bar is inserted through the lathe spindle, then the reamer is slipped into place and pinned. The work is bored with a boring tool held in the cross slide tool post. After boring, it is only

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RECENT Acracon Power Factor Condenser installations have relieved overloaded equipment and consequently reduced power costs tremendously for a large steel fabricating shop . . . a leading bakelite manufacturer . . . a large baking plant . . . and an electrical specialty factory.

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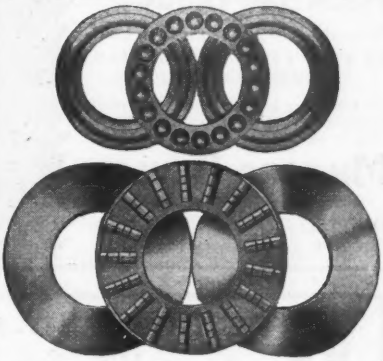
This fact is not surprising when one realizes that GUSHERS are simple and durable in their construction and give excellent performance on any type of machine.

The Ruthman Machinery Co.
532 E. Front St., Cincinnati, Ohio



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Special Bearings, Made to Order.
Send Sketch or Sample for Quotation.

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358 Furman St. Brooklyn, N. Y.

necessary for the operator to throw the reverse lever over so that the work will revolve in the opposite direction, take a couple of steps to the rear of the lathe, and feed the reamer through by hand. It is only necessary to hold the handwheel and push.

After reaming, the operator simply pulls the reamer back as far as it will go and lets it ride. It should be understood that this method cannot be used where the part to be reamed is chucked flush against the faceplate. It will work where the work is held in a chuck, or where the hole in the work is far enough away from the spindle nose to allow clearance for the reamer when not in use. It is especially adapted to the reaming of motor ends and caps, which is the job for which it is used most in our plant. We clamp the motor cap into a fixture on the faceplate with the large open end toward the spindle, and the closed end, which is to be reamed, toward the tailstock. Thus plenty of room is available for the reamer. We are holding the dimensions of our reamed holes within 0.001 in. limits, which is about as good as the usual turret lathe job.

A Different Hack Saw Blade

Fine teeth on forward end START THE CUT *on the* FIRST STROKE

No scraping to start cut—no teeth ripping—no slipping from cutting line — AND NO EXTRA COST.

MILFORD DUPLEX

Order from your distributor

THE HENRY G. THOMPSON & SON CO.
Est. 1876 New Haven, Conn.

Simple Indexing

By ROBERT MACGREGOR

THE drawings illustrate a method which was used, in the absence of a dividing head, to mill two slots directly opposite each other in a shaft. The shaft was clamped on a vise in a milling machine table and a clamp dog was fastened on one end. Then the shaft was adjusted so that the heads of the clamp screws lined up with a square as illustrated at **A**. The keyway was milled in one side of the shaft, then the shaft was turned over so that the heads of the screws again lined up with the square, as

WELDON END-MILL TOOL-ROOM KIT

Keeps Mills Safe and "Fit"

Saves time, loss, damage. No hunting through bins—Tools instantly checked up—Cover clamps mills in chocks. No. 1 Set contains roughers and finishers, 1/8" to 1/2" dia. inclusive. Tool-holder fits all mills in set. *Stocks in Principal Cities.*

HIGHEST SPEEDS-FASTEST FEEDS

The WELDON TOOL CO., 1426 W. 3rd St., Cleveland, Ohio

shown at **B**, and the opposite keyway was milled.

The complete set-up is shown at **C**. As ten pieces were required, each 3 in. long, a shaft was milled that was

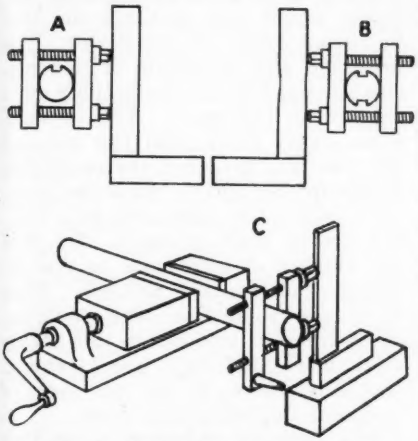

Illustration showing how a clamp dog was used to index a shaft 180 degrees

long enough so that it could be cut into ten pieces after milling, with enough extra to provide for the clamp dog. The method used was quick, practical, and accurate.

The most progressive manufacturer can give you the best service. The manufacturers represented here are among the leaders in their industry; patronize them and mention MODERN MACHINE SHOP when doing so.

KIPP Blue MIDGET

$7.75

FREE TRIAL

40,000 R. P. M.

The Kipp Blue Midget Air Grinder turns a small grinding wheel at 40,000 R. P. M. —50 to 100 lbs. air pressure. Weighs 7 oz. —nothing so small and fast has ever been seen before for grinding away metal in tool and die work—an amazing time-saver for finish grinding or polishing in holes, cavities or on plane surfaces. Made by Madison-Kipp Corp., world's leading manufacturers of small air tools—is light, easy to handle —fast as blue lightning. Sent complete on 10 day free trial to firms of satisfactory credit rating or cash with order with return privileges.

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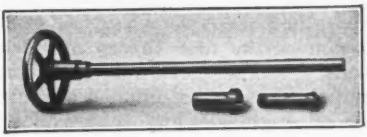

Collet Attachments for your lathes and millers

Write for Bulletin No. 100 A. M. — Rivett Draw-In Collets and Chucks. Also Price List and Dimension Sheet.

Rivett Lathe & Grinder Corp.

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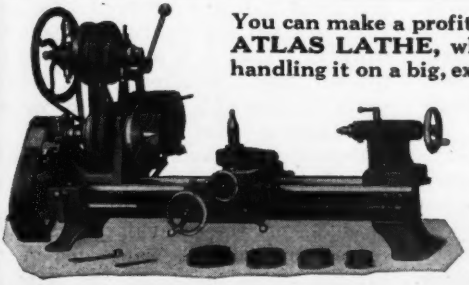

You can make a profit on many a job done on a $79.00 ATLAS LATHE, when you would show a net loss handling it on a big, expensive, power-eating machine.

Price of $79.00 includes everything shown except motor. 9" swing, 18" between centers, cuts standard threads from 4 to 80 per inch. Six speeds. Hollow headstock spindle, ¾" hole. A quality lathe in every respect; remarkable accuracy and power. 10 days' trial — money-back guarantee. Terms if desired. Write for full information.

ATLAS PRESS CO.

1846 N. Pitcher Street, Kalamazoo, Mich.

Over the Editor's Desk

"Happy New Year"

WE are very happy, indeed, to be able to call the attention of our readers to the fact that this issue of MODERN MACHINE SHOP is carrying a substantial increase in advertising pages — actually an increase of 48 per cent over the previous six months' average. This increase in business is an indication that machinery and equipment manufacturers are receiving orders from makers of metal products, who, in turn, are again in sight of markets for their wares. It is our wish that 1933 will see a return to normal business activity, which is the surest way we know of wishing our readers a "Happy New Year."

"Technocracy"

AS this issue of MODERN MACHINE SHOP goes to press, the newspapers and magazines are full of discussion of the new theory of "Technocracy." The technocrats, it seems, comprise an earnest-minded organization of engineers and scientists who are seeking to discover, by means of charts and graphs of the course over which civilization has thus far sailed, just what we are headed for and about when we may expect to arrive.

The high point in their findings to date seems to consist in that the rate at which workers are being displaced by machines is greater than the rate at which new jobs are being created, which would mean that we could look forward to a continuous and increasing problem of unemployment.

The old saw "You can prove anything by figures" is just as true today as it ever was. We won't go as far as some of their fellow-scientists, who denounce these men as "technocrazy," but we would like to submit a few figures on replacements of workers by the machine.

Let us go back to the spinning machine, which was probably the first important labor-saving device. The invention and perfection of this machine increased the productivity of a weaver by 700 times. Yet, in 1856, some eighty years after the spinning machine was invented, the employees in the British textile industries numbered 379,000 as compared with 218,000 twenty years previous. By 1914 the number of employees in this industry had reached 689,000. Thus while the population was doubling, the number of workers in this highly mechanized industry was trebling. Certainly there is no evidence of technical unemployment here.

The printing industry is another industry in which hand work has been displaced by machines at a rapid rate in recent years. It is estimated that machines have multiplied the production per man by from three to four times within the last thirty years, yet the number of persons employed in the printing trades today is three times as many as were employed in this industry fifty years ago. Again the theory of technical unemployment is disproved. These examples could be multiplied by hundreds.

According to James S. Thomas in "Nation's Business," the drop in American industry between 1920 and 1928 released approximately 2,000,000 workers. That is a huge army to be thrown upon the streets, and represents the loss of a vast sum in wages and salaries — but wait!

During that same period the number of workers employed in the driving and servicing of automobiles — a product of the machine age — increased by 750,000. Expansion in insurance fields increased the number

of insurance agents by another 100,000. Electric refrigeration, oil heat, and improvements in light and power provided employment for another 100,000. Construction work and management provided jobs for an additional 100,000, and motion picture theatre employees increased by 125,000. Radio — also a development of this machine age — created jobs for 200,000 people during this same period. The increase in travel, due largely to the automobile, has made necessary increased hotel and restaurant facilities for which an additional force of 750,000 people is required. "Altogether," Mr. Thomas says, "while the machine was displacing some 2,000,000 workers in America, the increased efficiency made possible by the machine was providing jobs for more than 2,500,000 people directly and some 2,000,000 more indirectly." The difference more than accounts for the increase in population during the period. At the same time the per capita earning power was increased and the standards of living were raised.

Again we say — as we have said in previous issues of MODERN MACHINE SHOP — that while hundreds of thousands of people in this country are without shoes, clothing, fuel, furniture, and food, the absence of foundation for the theory of over-production is obvious. With warehouses on the one side filled with food, clothing, and other necessaries of life, while on the other side are thousands of people who are suffering for the lack of these same necessaries, the problem is obviously one of distribution. When the needs of the destitute and suffering have been filled, if there is any surplus, then — and not until then — will we be ready to listen to theories concerning the evils of over-production as caused by the development of labor-saving machines.

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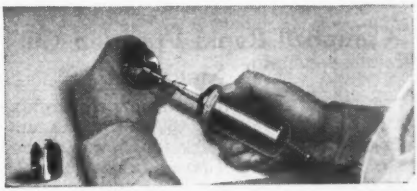
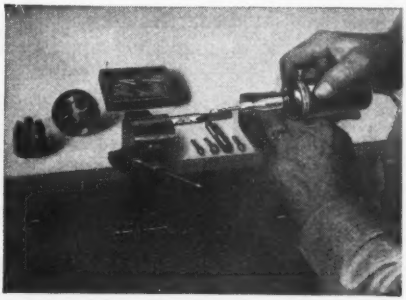
One of Many Uses of the New Hand-ee Grinder. Plug in anywhere. Works on A. C. or D. C. 10,000 r.p.m.



Gun taps, all types of machine and hand taps.



Acorn dies, round dies, die chasers sharpened

—Ground to the proper shape of cutting edge for the metal being threaded.

Use the Hand-ee Grinder at the machine or at the bench for light grinding in hard-to-get-at places, experimental models, etc. Smooth off, touch off, dress up with machine efficiency. Sold on five-day free trial, direct or from your supplier. $10.00, with three wheel shapes free. Order today.

M. C. TOOL COMPANY

110 South Aberdeen Street, CHICAGO, ILL.
DETROIT, 14 Smith St., Telephone, MAD. 1715

M. C. TOOL CO., 110 S. Aberdeen St., Chicago

Send Hand-ee Grinder for 5-day trial. Price $10 with the three wheel shapes checked below.

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Company.....

City..... State.....MMS1

NEW SHOP EQUIPMENT

Campbell Rapid Precision Cut-Off Machine

A rapid precision cutting off machine that is especially adapted for the cutting of hard materials such as hardened steels, tool steel, glass tubing, nickel, and so on, and plastic materials which are difficult to cut or which dull ordinary cutting tools rapidly, has been placed on the market by Andrew C. Campbell, Inc., Bridgeport, Conn. The feature of the machine is that the cutting is done while the work is immersed in a coolant, by a thin rubber-bound carborundum wheel rotating at high speed, the rate of cut being regulated automatically by an oil dashpot fitted with a variable outlet orifice.

Campbell Rapid Precision Cut-Off Machine

The machine makes a clean, smooth cut without glazing, burning, or burring the piece, and the dimension of the cut piece can be held within close limits, said to be not more than 0.001 in. in some cases. As the piece is submerged during the cutting operation, any tendency to burn is eliminated. The coolant takes care of the cuttings and also minimizes the wear on the wheel so that maximum life is obtained.

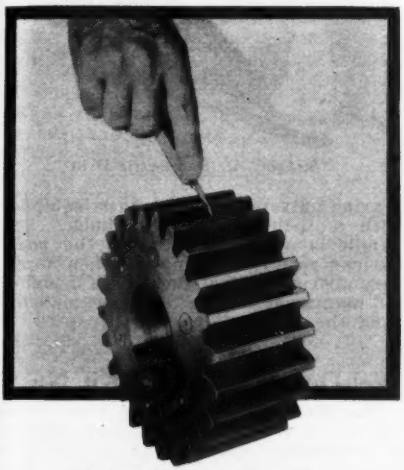
For convenience in feeding, the spindle is mounted on one end of a pivoted arm and the motor that drives it is mounted at the opposite, or rear, end. Double V-belt drive is provided, the motor having a pivoted mounting which permits of ready adjustment for belt tension. The spindle is mounted in ball bearings.

In action, the wheel moves downward into the work, which is held in a quick-acting clamp comprising a spring-depressed lever that holds the work firmly in a pair of submerged V-blocks, one of which is adjustable. The downward motion of the wheel is controlled in part by an adjustable counterweight and in part by a dashpot, the plunger of which moves downward as the arm swings and the cut proceeds. The outlet orifice in the dashpot is adjustable to control the rate at which the arm lowers. Electric contacts close as soon as the cut is completed, lighting a lamp and thus notifying the operator that the cut is finished.

The bed of the machine is of cast iron, mounted on a single pedestal and surrounded with a rim by which the coolant is retained. A trough can be applied, as shown in the illustration, to handle long work, the bed without the trough accommodating work to 20 in. in length. The machine is available in two sizes, equipped with 1 and 2 h.p. motors. In both the maximum wheel size is 16 in., to take stock up to 3 in. diameter. The spindle speed is 1,800 r.p.m. Parts that are submerged are made of bronze.

Waldron All-Steel Silent Gear

The combined qualities of silence and long wear are said to be the features of the all-steel silent gears and gear blanks now being marketed by the John Waldron Corporation, New Brunswick, New Jersey. The gears are manufactured by a method that combines with the strength and long life of steel the added advantages of silent operation and self-lubrication.

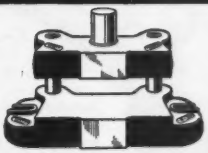


Waldron All-Steel Silent Gear

The gear blanks are built up of thin sections or laminations of sheet metal, coated with graphite and subjected to tremendous pressure. The gear, when cut and finished, has the appearance of a ground steel gear of ordinary construction. However, the laminated construction prevents noise vibrations from being transmitted, with the consequence that the gear is silent in operation.

Waldron All-Steel Silent Gears are said to be free from brittleness and tooth breakage, due to the fact that the laminations are strong, elastic, and ductile. The gears may be mated with each other or with gears of other materials, and are frequently employed as pinions or idlers

BAUMBACH



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Made foot-operated and automatic motor drive. For welding from .0005" to 5/8" combined thickness.

Welders for fine work priced as low as..... $55.00 SUBMIT YOUR PROBLEMS

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Distributor and Dealer Connections Desired

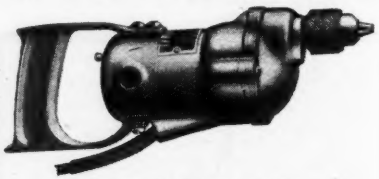
Automatic

in spur gear trains to dampen vibration and secure noiseless operation. Gears are available finished, or blanks may be had in standard or special sizes.

"Midget" U. S. Electric Drill

An electric drill that can be operated in exceptionally small quarters, to be known as the "Midget," has been announced by The United States Electrical Tool Company, 2471 West Sixth Street, Cincinnati, Ohio. The drill is only 8 in. long and weighs but 3½ lb., making it easy to handle and convenient to carry.

The "Midget" is compactly built, having an aluminum body and double reduction, hardened chrome manganese steel gears which operate in a grease-tight compartment. It is powered by a ball



"Midget" U. S. Electric Drill

bearing universal motor, and is equipped with a ¼-in. screw-back chuck. The handle is securely bolted to the body, but can readily be removed when necessary. Every part of the tool is designed for maximum service and workmanship is of the usual "U. S." quality.

Wel-Don Tool Room Kit No. 1

The Weldon Tool Co., 1426 West Third Street, Cleveland, Ohio, is now offering a convenient kit that is designed to preserve end mills in the tool room from

Wel-Don Tool Room Kit No. 1

loss or damage. The kit contains a complete set-up of end mills, both roughers and finishers, from ⅛ in. to ½ in. diameter, inclusive, together with a

The Mummert-Dixon Spot Facer

. . . enables you to machine accurate and smooth surfaces on small bosses, etc., in less time than by any other method. Better investigate! Send for a bulletin.

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PROTECTS HANDS

Rubbed into the hands before starting work—forms a protective film.

Not greasy or sticky. Washes off in running water, taking all oil, grease, paint and dirt with it. No hard scrubbing necessary. No chapping or cracking. ***Send 10c for a generous sample.***

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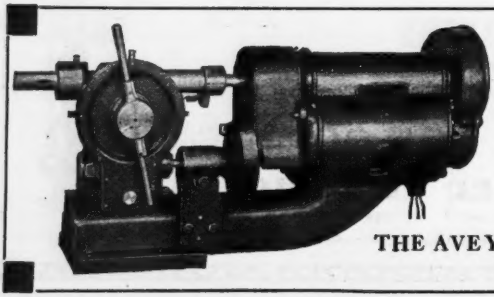

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Write today for details and instances of unusually profitable applications. No obligation.

THE AVEY DRILLING MACHINE CO.
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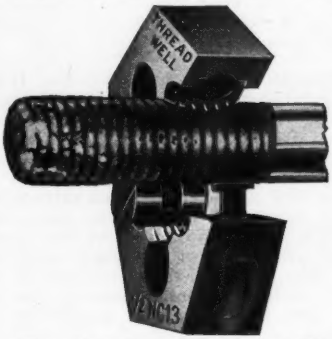
wrench and tool holder that takes the ⅜-in. parallel shanks with which the mills are provided.

The end mills from ⅛ in. to ⅜ in. diameter are of the double-end type, the ⅞-in. and ½-in. being of the single end type so that they can be used in the same tool holder as the smaller sizes. Each article in the kit is held in a wood chock, which makes it easy to note the absence of any tools that are missing. The closing of the box lid clamps each tool firmly in position in the kit and prevents the tools from striking each other.

Threadwell Hexagon Opening Die

A die that can be removed from a thread after cutting without the necessity of backing off, or which can be positioned at any point on a thread

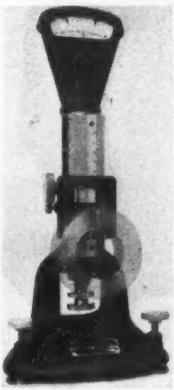


Threadwell Hexagon Opening Die

without being threaded on from the end, has been placed on the market by The Threadwell Tool Co., Greenfield, Mass. The die is provided with a hinge and lock so that it can be easily opened, and as easily locked in position by turning the lock screw one-half turn.

When closed and locked, the die is as rigid as a solid die and is as efficient in the cutting of new threads as any die of the solid type. It is especially efficient in the rethreading of jammed or bruised threads, as it can be clamped in position at any point on the thread. When the jammed threads are at the end of the screw, the die can be positioned on the thread back of the end and threaded off the end, producing a clean thread.

The hexagon shape of the die permits the use of any kind of holder available,



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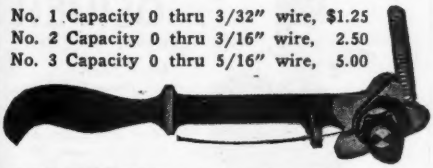

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The HJORTH Perfection Spring Winder offers the ideal means of winding extension, compression, torsion, taper, double taper, or left hand springs. Try one in your shop.

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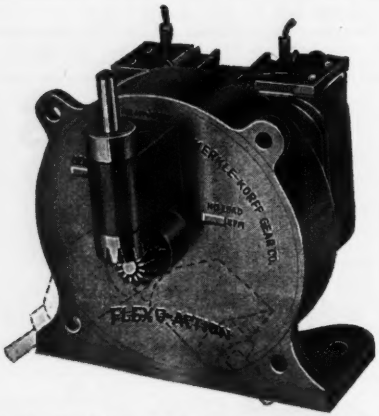
such as a vise or wrench. It is adjustable for tight or loose fits, and can be supplied in any standard or special size.

Merkle-Korff Reversible Power Reduction Unit

The Merkle-Korff Gear Company, 215 N. Morgan Street, Chicago, Ill., has augmented its line of precision power reduction units by the addition of a unit



Merkle-Korff Reversible Power Reduction Unit

containing a two-pole reversible motor. It is designed to start, stop, and run in either direction under the control of a switch of the simplest possible design. The 115-volt, 60-cycle current is considered as standard, although special units can be furnished for any voltage from 15 to 130 and for any frequency from 25 to 60 cycles.

The unit operates at a full load speed of 1,500 r.p.m., and a no load speed of 2,600 r.p.m., and can be furnished with either horizontal or right angle drive. Over-all dimensions are: Depth, $3\frac{7}{16}$ in.; Height, $3\frac{5}{16}$ in.; Width, $3\frac{1}{2}$ inches.

"Hand Save"

The Stanley Chemical Co., East Berlin, Conn., is now marketing a product known as "Hand Save" which, when rubbed into the hands or arms, forms a protective film that is said to be impervious to grease, oil, paint, lacquer, varnish, and other similar substances. It is especially useful in the machine shop for use where the operator is required to have his hands in oil a large part of the time, such as in the operation of screw machines, turret lathes, etc. The manufacturers claim that "Hand Save" keeps the skin healthy and prevents cracking or chapping.

The product, which is in paste form, is neither sticky nor greasy and can easily be washed off the hands with running water. It is marketed in one-pound cans.

Colonial Broach Catalog No. B-62. This catalog, issued by Colonial Broach Company, 145 Jos. Campau Street, Detroit, Michigan, comprises a complete reference book on modern broaching equipment. It contains 90 pages, 8½ x 11-in. in size, printed on heavy enameled stock. The text comprises a complete catalog of the kinds, types, and sizes of broaches made by this firm, and includes a number of pages of information regarding the use and care of broaching equipment in general.

The book is profusely illustrated with pictures of the broaches and equipment with which they are used, and a number of drawings of the various jobs are included in the natural blue-print color. Copies of the book are available to mechanical executives.

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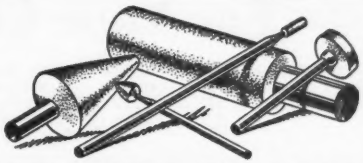

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Lubrication by Barrel-To-Bearing System: The most modern system of lubrication for machine tools is described in a folder that can be had by writing to Alemite Corporation, 2680 N. Crawford Ave., Chicago, Ill.

Chucks—Key and Keyless: Bulletin No. 120A, issued by T. R. Almond Mfg. Co., Ashburnham, Mass., describes and illustrates the line of key and keyless geared nut and ball bearing drill chucks made by this firm. Copy free upon request.

Cut Your Sawing Costs: "Lenox" hack saw blades and band saws are guaranteed to effect savings on your sawing operations. Write for information to American Saw & Mfg. Co., Springfield, Mass.

Machine Shop Accessories: Catalog B-27, issued by the Armstrong Bros. Tool Co., 328 N. Francisco Ave., Chicago, Ill., describes the line of tool holders, boring tools, wrenches, pipe tools, ratchet drills, lathe dogs, and other tools manufactured by this company.

"Atlas" Bench Lathe: A 9-in., screw cutting, self-contained, motor-driven bench lathe is now being built by Atlas Press Co., Kalamazoo, Mich. Write for circular.

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Diamond Boring: The newest methods of diamond boring all kinds of bearings, gears, motor frames, small bushings, and other similar work are outlined in a bulletin that also describes and illustrates three new diamond boring machines. A copy can be had by addressing the City Machine & Tool Works, 1521 East Third Street, Dayton, Ohio.

Information for Broach Users: Catalog B-62, issued by Colonial Broach Co., 145 Jos. Campau St., Detroit, Mich., is a complete reference book on modern broaching. Copy free upon request.

Cut Your Power Costs: Many plants are wasting money on excess power. Learn how your power costs can be reduced by writing to Condenser Corporation of America, 261 Cornelison Ave., Jersey City, N. J.

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The Red Liner is an automatic machine that inspects gears under conditions similar to those of actual operation, and charts errors on a 200-to-1 scale. Write Fellows Gear Shaper Company, Springfield, Vt., for booklet.

Performance Data On Swiss Jig Borers: This 36-page pamphlet shows various types of jobs from a power shovel turntable jig to a television disc, drilled and bored on Societe Genevoise High Speed Precision Borers, giving data as to size of holes, accuracy and time savings. Free upon request to The R. Y. Ferner Co., 1008 K Street, N. W., Washington, D. C.

Formica Silent Composition Gears: A booklet telling about the uses and advantages of Formica Silent Shock Absorbing Gears, and containing a considerable amount of valuable data with rules and tables for laying out, cutting and using gears. Sent free by Formica Insulation Co., 4632 Spring Grove Avenue, Cincinnati, Ohio.

Stampings of any kind or size can be obtained from Gerding Brothers, 5 East Third Street, Cincinnati, Ohio. Write for particulars.

Dynamic and Static Balance: Full information as to what static and dynamic balance means, the necessity for correct balance in rotating parts, methods of discovering and correcting unbalance, and the uses of balancing equipment can be had without charge by addressing Globe Tool & Engineering Co., Dayton, Ohio.

Ball and Roller Bearings, either journal or thrust, for all purposes and in all sizes, are described and illustrated in catalog No. 9 which has been issued by The Gwilliam Company, 360 Furman Street, Brooklyn, N. Y. Copy free upon request.

Grinding, Polishing and Buffing Machines of the latest types are described and illustrated in a series of bulletins that have been issued by the Hammond Machinery Builders, Kalamazoo, Mich. Copies free upon request.

Precision Bench Lathe Work can only be done on finely-built, accurate machines. The complete line of Hjorth Precision Bench Lathes is described and illustrated in a catalog that has been issued by Hjorth Lathe & Tool Company, 60 State Street, Boston, Mass. Copy free upon request.

Threading Machinery: Complete catalogs of individual bulletins covering the pipe threading and cutting machines, bolt threading machines, or die heads made by Landis Machine Co., Waynesboro, Penna., may be had upon request from this firm. State size and type of machine or die head concerning which information is required.

Air-Operated Work-Holding Devices: A booklet showing how air-operated chucks and devices of various kinds can be applied to different kinds of machines to save time and labor has been issued by The Logansport Machine Co., Logansport, Ind.

Grind at 40,000 R.P.M.: The Kipp Blue Midget 40,000 r.p.m. air grinder, weighing 7 oz., is described in a folder that can be had by writing to Madison-Kipp Corporation, 219 Waubesa St., Madison, Wis.

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Die Making Machines: How dies, templates, gages, etc., can be sawed out, filed, and lapped easily and accurately on Oliver die making machines is fully described in a bulletin issued by the Oliver Instrument Company, 1430 Maumee Street, Adrian, Mich. Mailed upon request.

Good Gears of all kinds—spur, spiral, bevel, worm, hypoid—in fact, any kind or type of gear desired, large or small, machined to an excellent finish and the highest degree of accuracy, may be obtained from Perkins Machine & Gear Co., 151 Circuit Ave., Springfield, Mass. Write for estimates.

Bench Lathe Mounting and Driving Equipment: Bulletin 120-A, issued by Rivett Lathe and Grinder Corporation, Brighton, Mass., contains complete descriptions and illustrations of modern and conventional countershaft, individual motor drive jackshaft, and speed box motor drive, also benches, cabinets, oil pans, etc. Copy free upon request.

Automatic Lubrication: Individually motor-driven pumps that keep the work flooded with lubricant are described in a booklet that has been published by the Ruthman Machinery Co., Front and Pike Sts., Cincinnati, Ohio.

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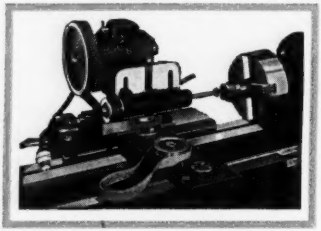
Eighteen years ago, at the Panama Pacific International Exposition at San Francisco, the judges pinned the blue ribbon on this U. S. Precision Lathe Grinder. Today it still is the leader for accurate grinding in shops, large and small, all over the world.



Considering everything — construction — performance — operating cost — maintenance — etc., there is no other portable grinder in the class with this U. S. Type HLLU. It has a wider range for accurate grinding (external, internal and surface) than any other built. It is unexcelled for use on 10" and larger lathes, and will grind within 2" of the maximum lathe swing.

Whether or not you are considering an immediate purchase of a grinder (or any other electrical tool) you should have a copy of the U. S. catalog for reference. It describes and illustrates the most complete line of Drills, Grinders, Buffers, Polishers, etc., that is built. We shall be pleased to give you a copy without charge or obligation. Write today!

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